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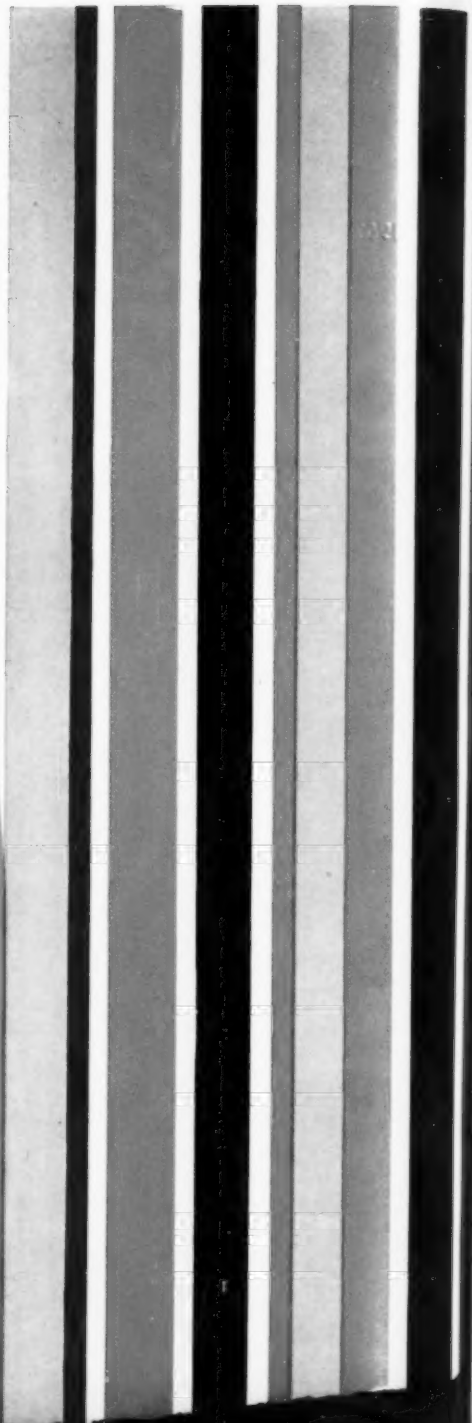
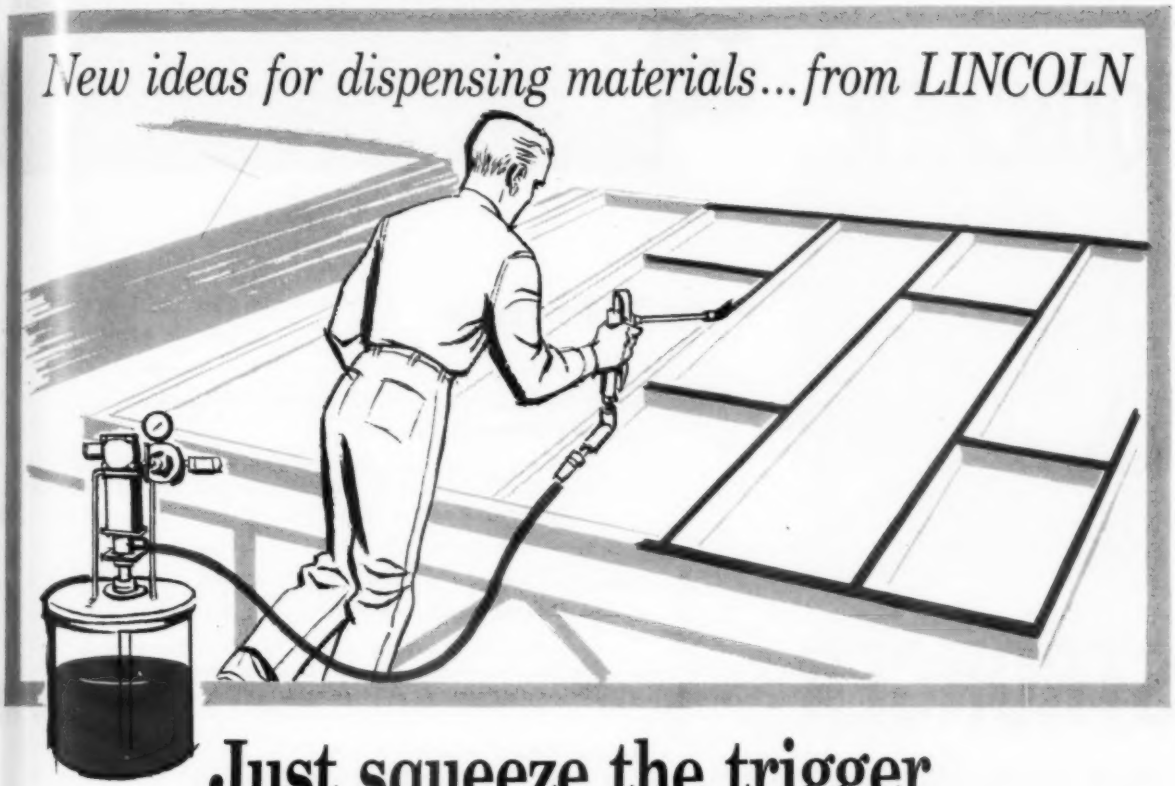


New ideas for dispensing materials...from LINCOLN



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About the Cover Design

The photograph on this month's cover is a close-up view of bonded printed circuits leaving the embossing press. In this step, heated dies simultaneously stamp out the circuit pattern and bond the adhesive-coated copper to the baseboard. A step-by-step description of this production technique is given on page 20.

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PP

DECEMBER, 1961

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Indexed in Applied Science and Technology Index and Engineering Index
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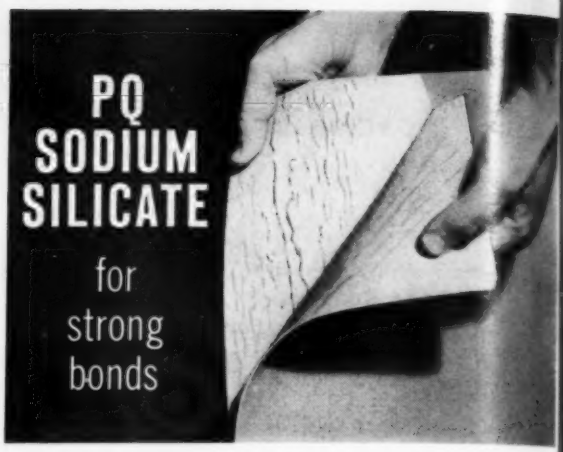

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EDITORIAL

To...

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each and every bone glue chooser

one and all phenolic blenders

dextrine and to starch paste vendors

corrugators, blood glue buyers

latexers of cord for tires

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impregnators and to tapers

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all of you and with good reason

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CONSULTANT'S CORNER

By Dr. Irving Skeist

Wool Felt to Steel

Question: In manufacturing plywood and panels, we operate a three-drum sander. The steel drums are covered with a sheet of wool felt and then the abrasive paper is drawn tightly around. The felt must be held firmly — no air pockets.

We need an adhesive that will permit quick renewal of the wool felt. The adhesive should not stick so tightly to the steel that a machine-motivated abrasive is needed to clean the drum.

Answer: You need an adhesive that will keep the felt well bonded to the steel during use, but can be removed easily. A soluble or dispersible adhesive seems to be in order. Adhesion to the steel will be more difficult than to the wool, and the steel surface should be cleaned well.

The possibility of heat build up in this application excludes most thermoplastics from consideration. Among the materials which may be useful are polyvinyl butyral dissolved in isopropyl alcohol, or shellac dissolved in methanol. These polymers might have to be compounded with various other ingredients to give them suitable properties. They should be removable with the same solvents, possibly with the aid of steam.

Q-203

More on Wood to Concrete

Our July, 1961 issue carried an item from a church pew manufacturer (Q-190) who wanted to know if an adhesive was available to attach oak pews to concrete floors in which were imbedded radiant heating pipes. Products Research Co., Gloucester City, N.J., advises that their PR 940, a two-part epoxy patching compound, is suitable.

Dr. Irving Skeist is associated with Skeist Laboratories, Inc., 89 Lincoln Park, Newark 2, N. J. He is the author of the book "Epoxy Resins."

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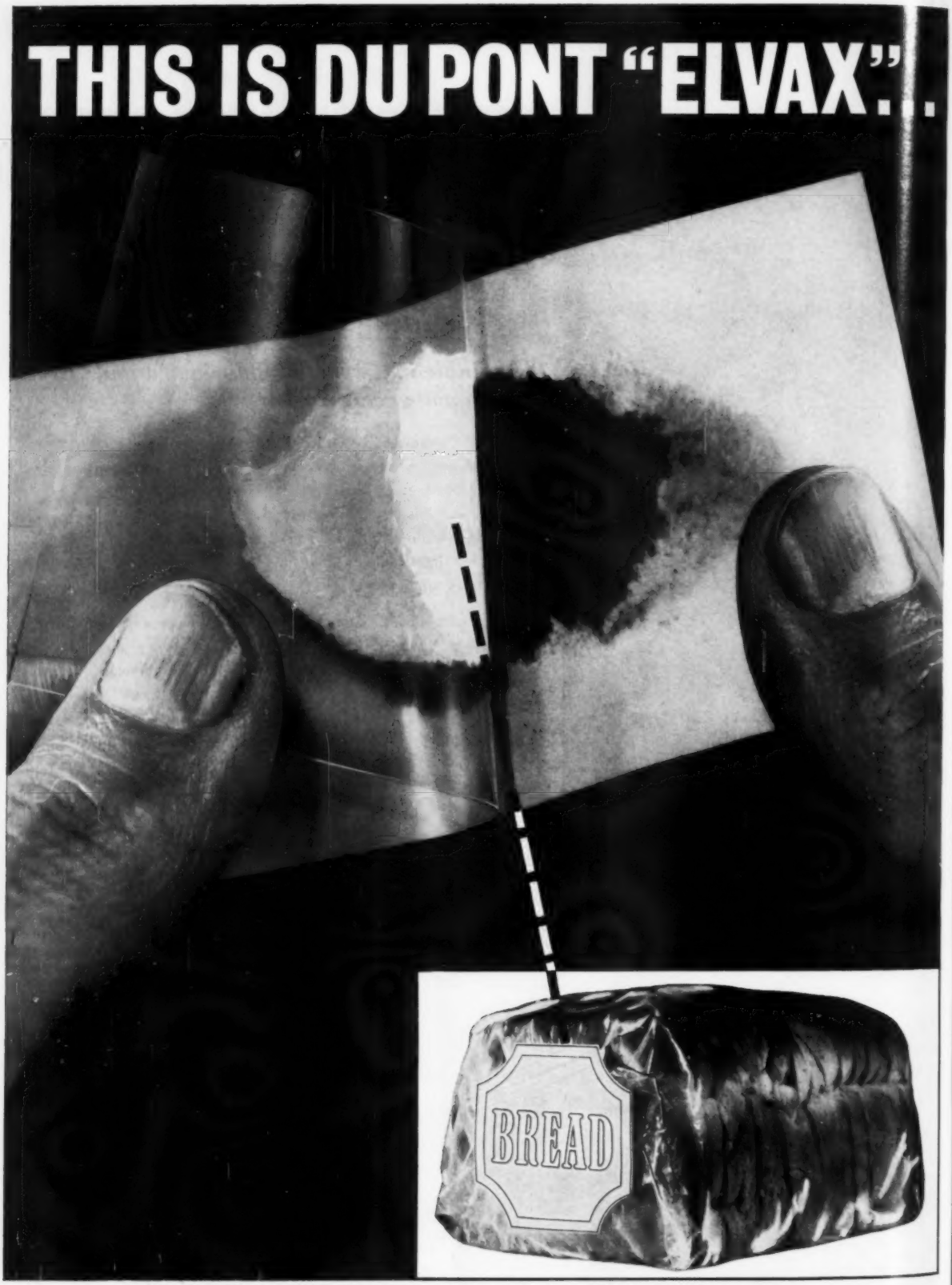

Coatings based on "Elvax" heat-seal to all films used in packaging today. Adhesive strength of wax extended with 40% "Elvax" is shown by fiber-tearing bond obtained when paper coated with "Elvax" is heat-sealed to polyethylene. This feature makes "Elvax" ideal for such applications as affixing end labels on polyethylene bread wrappers.

a new vinyl resin wax extender of superior adhesion and toughness... now available in commercial quantities

"Elvax" is a new high-molecular-weight vinyl resin that makes possible low-cost wax coatings of superior adhesion, flexibility and toughness with excellent water-barrier properties. "Elvax" is now available in commercial quantities for your use or evaluation.

With "Elvax" you can, for the first time, control the water-vapor transmission rate (WVTR) of wax coatings simply by varying the ratio of "Elvax" to wax. When 30% "Elvax" is blended with wax, flexible 1-mil coatings with flat and crease WVTRs of 0.2-0.4 gms./100 in.^{2}/24 hours are obtainable. (In addition, resistance to grease penetration is improved significantly.)

Flexible, tough adhesive bonds are obtainable using "Elvax" alone or blending it with waxes, resins, rosins or rosin derivatives. Hot-melt, solvent and pressure-sensitive adhesives based on "Elvax" adhere tightly to all films used in packaging. For example, bread end labels, such as the one shown at the left, can be securely affixed to polyethylene bread wraps with low-cost, hot-melt adhesives based on "Elvax". This is just one of the many product improvements made possible by new Du Pont "Elvax". Other applications include: improved coatings for frozen-food overwraps, waxed glassine, waxed cartons . . . wherever low-cost, heat-sealable coatings with excellent water-barrier properties are required.

Perhaps you, too, can utilize "Elvax" to good advantage . . . get greater versatility in packaging and an improved product. Why not evaluate it for yourself . . . now! Write for our booklet and technical information on "Elvax", describing properties, methods of application and possible uses. Du Pont, Electrochemicals Dept., Rm. D2064, Wilmington 98, Delaware.

Translucent, free-flowing pellets of "Elvax" vinyl resins are packed in easy-to-handle 50-pound multiwall bags. You can order "Elvax" now in commercial or evaluation quantities.

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Concresive No. 1 Long Pot life is a product primarily formulated for those who desire longer working times, such as in the bonding of new concrete to old concrete

over large areas. The material is brushed, sprayed or rolled over clean, existing concrete, and, when tacky, new concrete is poured directly over it. At an ambient temperature of 70°F., the adhesive has a working time of 90 minutes from the start of mixing to placing the new concrete. The Concresive cures with the concrete and the bond strengths produced are far greater than the concrete. *Adhesive Engineering.*

P-564

Thermosetting Adhesive

A thermosetting resin, designed to bond nylon to nylon, has a heat stability which is said to be excellent at temperatures up to and above the softening points of most plastics. Called Raiseal 5002, this adhesive demonstrates excellent alkaline resistance. Tensile shears are 400 psi after a four hour cure and 192 psi after two hours at 250°F; peel strength is 11 pounds per inch after a two hour cure at 250°F. The material is also finding broad application in the bonding of nylon to most metal and plastic surfaces. *Radiation Applications, Inc.*

P-565

Rubber-to-Metal Adhesive

EX-B579-1, an adhesive for bonding RTV silicone rubber to metal, provides bonding during the room temperature cure of silicone rubber compounds. Rubber-tearing bonds are produced which are said to have excellent environmental resistance to broad temperature conditions. This one-part, one-coat adhesive does not stain. Excellent bonds can be obtained with a wide variety of RTV silicone rubbers to steel, aluminum, brass, copper, and other metals as well as glass, porous ceramics, cured epoxies, phenolics and other resins, synthetic fabrics and treated teflon. Adhesive EX-B579-1 is said to be well suited to the processing and performance standards of the electronics industry where RTV silicones are used for potting and insulating of connectors and other components. *Hughson Chemical Co.*

P-566

Freezer Adhesive Tape

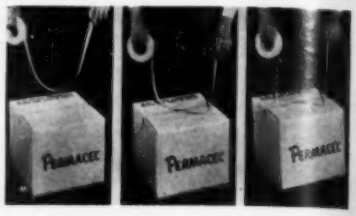
C-633, a rope paper backed adhesive tape has been designed primarily for frozen foods. The tape is particularly designed for low-temperature packaging jobs, such as sealing wrap on frozen foods, bundling frozen packages, and sealing cartons while in the freezer. It can also be used for holding and bundling loose parts and securing doors, lids, attachments and parts on equipment being prepared for shipment. The tape can also be used for splicing operations on paper and cloth finishing machinery. Its printable paper backing makes it suitable for labeling. *Arno Adhesive Tapes, Inc.*

P-567

FOR MORE INFORMATION on the new products described on this page use the Readers' Service Coupon on page 44.

"Instant Grab" Tape

Permacel 162 was specifically designed for instant grab to corrugated cartons for high speed packaging applications. The pressure-



sensitive tape has a clear film backing and glass filament reinforcements giving the tape a tensile strength of 325 pounds to the inch. It is used both to seal and reinforce cartons and is also suited for bundling, unitizing and strapping items made of metal, wood, glass and plastic. *Permacel.*

P-568

Pressure-Sensitive Adhesive

A new adhesive film which assures bonds instantly via the application of heat and moderate pressure obtains bonds at a temperature range of 150 to 250°F. for three to five seconds with standard-squeeze-roll pressures. When maximum bonds are required, a cycle of 300 to 400°F. for five to 10 seconds and five pounds psi and higher should be used. Resultant bonds are said to give tensile shears of 1000 to 1500 psi immediately upon stabilizing at room temperature. Designated GP Pre/Set Bonding Film, this material is reported to have good shelf-life. *Girder Process, Inc.*

P-569

Adhesive-Backed Nameplates

Super/Cal, adhesive-backed nameplates are available in four standard versions — quick releases paper backing, water release liner, solvent activated and heat activated adhesives. Outstanding feature of the nameplates is their special A.C.R.S. (abrasion, corrosion, resistant, surface) surface sealing treatment. This process gives aluminum an extremely corrosion and abrasion coating, improves color fastness of nameplates, and lends better dielectric properties. *Aluminum Nameplate Corp.*

P-570

What else can GANTREZ* AN do?

(it's a protective colloid and helps thicken/suspend/cure/paste/tackify/form films/retard rust/impart heat stability . . . it improves wet grab, shear strength, specific adhesion)

tell us. C emists have been applying GANTREZ* AN in in- tries from brasives to cosmetics . . . and so far have come up 51 applic tions! (Patents, too) Use it for pressure-sensitive wood gl adhesives, for water remoistenables and lami- es, for PV based coatings and polyurethane binders, even nks. See or yourself. You should be pleased, you may be surprised. And like some other eager chemists . . . you may surprise others. Try a sample. Three viscosity grades. Write Dept. D9.

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*Trademark of General Aniline & Film Corporation. GANTREZ AN resin is a water-soluble, linear copolymer of methyl vinyl ether and maleic anhydride.

• **Paris Plastic Exhibit.** Europlastique 1962 is the theme of an exhibit which will be held in the latter part of May, 1962, in Paris. At that time, a large technical exhibition, the Biennale Technique de Paris, will be staged. It will consist of four special exhibits: Adhesives and Rubbers, Mechanics and Electricity, Construction Materials, Shipbuilding and Plastics.

Europlastique 62 will be sponsored by French industrial organizations and manufacturers of machinery for the processing of plastics, adhesives and rubber. An international meeting of experts from all parts of the world will be arranged during the exhibition. Information can be obtained by contacting: Europlastique 62, 10 Rue du Mont Thabor, Paris 1, France.

• **Russian Research Activity.** A survey of chemical literature growth by the director of Chemical Abstracts Service would indicate that research activity on chemistry and chemical engineering by the USSR will overtake U.S. efforts by 1965 if the growth rates in both countries continue at their present pace. During 1960 a total of 132,150 papers were published in all countries. Of this total, U.S. research accounted for just over 27 per cent, the highest of any country. Soviet research accounted for slightly over 19 per cent, followed by the British Commonwealth with nearly 14 per cent. As measured by the Abstract Service, the total number of papers produced by the USSR and other Soviet Bloc countries (including Communist China) represented a combined total of 26.5 per cent of all papers published in 1960.

• **Polish Construction.** Soviet natural gas will be the raw material for a large chemical complex being built at Pulawy, Poland. While most of the output of the center will be nitrogenous fertilizer, a PVC facility with an expected output of 200,000 tons in 1970 is also in the planning stages.

• **London Packaging Exhibition.** While packaging has been the subject of a great deal of controversy in the United States, the English seem to take a more conservative view of things. The International Packaging Exhibition, recently held at Olympia, London, September 5-15, for instance, was not accompanied by televised government expose's of half-empty candy containers. It did, however, bring to public attention a considerable number of interesting and new adhesives applications.

Such items as plastic tapes, special adhesives for bonding films, labels, and other materials were in evidence, along with "breathing" acetate films and shock-proof mountings. One line of adhesives were especially formulated for flexible packaging applications with Pliofilm, Saran, Melinex, treated polyethylene, cellophane, and cellulose acetate and other films, including vinyls.

Just prior to the exhibit, Evode Ltd., an English firm, announced a new adhesive for polystyrene. This item is designed to meet the special requirements for an adhesive to bond expanded polystyrene (foam) to wall and ceiling surfaces of plaster, cement, hardboard, timber, and flat asbestos sheeting.

This material was developed through the efforts of the Industrial Adhesives division of the firm and carries the tradename Evo-Stik Impact Adhesive, SL-863.

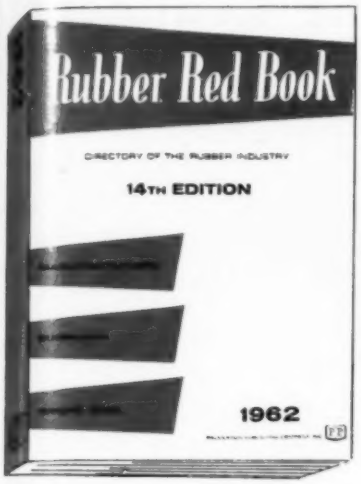
• **Expansion in Scotland.** Acrylonitrile-butadiene-styrene polymers for sale in Great Britain and on the Continent will be produced at a new plant being built by Borg-Warner's Marbon Chemical division in Grangemouth, Scotland. The operation has the cooperation of Britain's Anchor Chemical Co., of Manchester.

Other recent English expansion plans reported include the following: Howards of Illford, Ltd., is planning construction of plants to make dicyclohexyl phthalate, cyclohexanol, and cyclohexanone.

Concurrently, an European chemical market research association has been speculated as the outgrowth of a recent meeting in London of 25 chemical representatives from seven European countries.

• **Greek Fiberboard Factory.** The Export-Import Bank of Washington has authorized a credit of $2.5 million to Xelotex Industries, in Salonika, Greece, for the purchase of U.S. equipment to outfit a fiberboard plant near the city. Daily capacity of the unit, once producing, is expected to be 100 tons. A local market and local sources of raw materials for the installation are said to exist.

• **European Chemical Market Directory.** A directory listing 6,000 European chemical companies of the Common Market, and the Free Trade Association, has been published by Foster D. Snell, Inc.



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On the Continent

(cont'd)

• **Sealing Joints and Curtain Walls, France.** The type of architectural construction known as the curtain wall has been the object of a great deal of both study and criticism during the past twenty years. Architects, designers, engineers, and the general public have been involved, to say nothing of the suppliers of the materials of construction.

Criticism, where it has arisen, has focused in part on the asthetic factors; in part on the best use of the materials available; and in part on the function of the curtain wall building itself. Some of the most devastating attacks of all come from occupants of curtain wall buildings who have been exposed to the cold winds of winter and the rain of summer through the faulty seals between the prefabricated elements and the windows.

This aspect of the problem is, of course, a function of dimensional variations caused by expansion and contraction phenomenon, and it is this problem which is reviewed in a recent copy of the French trade journal, *Revue Generale du Caoutchouc.* A series of tests was designed to determine the most adequate adhesive-elastic material for sealing these joints. The author concludes that neoprene sections, when carefully designed and set up, are able to ensure perfect sealing during the whole life of the building, in addition to providing excellent noise and heat insulation.

• **German Firm Expands.** Rheinische Olefinwerke, a joint German petrochemical venture of Badische Anilin & Soda Fabrik and Deutsche Shell, reports that it has invested some $112.5 million in six plants. The company's ethylene production capacity has been raised to 150,000 tons yearly from 10,000 in 1956 and 50,000 tons in 1959. The firm is also expanding epoxy resin capacity to 5,000 tons a year from 3,000 tons.

• **Austrian Production of Chemicals Up.** The gross production value of the Austrian chemical industry amounted to about $400 million in 1960, up about $60 million from the 1959 total. For the first time, the chemical industry surpassed the output of the textile industry, to become the second largest industry in the nation. Most important increases over 1959 were noted in plastic materials and products, basic organic chemicals, inorganic chemicals, rubber goods and pharmaceuticals.

• **Gummed Label Paper.** An English firm, Smith & McLaurin Ltd., reports that it has perfected a special gummed label paper for "tough" adherent roles, such as varnished surfaces, plastic films, and the like. The firm also has introduced a new high-gloss aluminum coated paper.

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1959, 296 pages, with bibliography

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capitol cues

PRESIDENT KENNEDY IS SOFT-PEDALING HIS NEW FRONTIER these days...only temporarily. The pressure of events is forcing him to veer over toward the middle of the road. The Berlin crisis and a Congress that grew increasingly balky at the end of the last session have led him to play down some of his pet projects--the programs that were to give his term so much of its flavor.

> Kennedy regrets the need to go more slowly, but he's always been an intensely practical politician, ready and willing to face reality. So...until foreign and domestic conditions change...you will see new concern about what programs cost.

THE WHITE HOUSE HAS ORDERED CUTS IN NONDEFENSE SPENDING "wherever possible"--to keep the deficit for the current fiscal year from exceeding the $7 billion just estimated. President Kennedy is acutely aware of the danger of inflation and gold losses that rising deficits can bring. But he is discovering--as Eisenhower did before him--that spending is hard to cut.

> The government has lost control of many kinds of spending. Farm aid depends on harvests. GI benefits and debt interest are fixed. And people don't want to trim health research, postal services, or highway work. Some outlays can be cut. but they don't account for a big part of the total. Indeed, rising defense spending also threatens next year's balance.

THE BUSINESS OUTLOOK IS STILL VERY PROMISING, despite the soft spots that have cropped up in the past month or two. More than a few economists were disappointed by the consumer's sluggishness in stepping up his rate of buying. But now they think they see the start of an upsurge in retail sales. So the experts still look for a fast finish to 1961, and good gains in 1962.

> The slowdown that started in September was only temporary. It reflected a combination of negative factors not likely to recur--auto strikes...unseasonal weather...worry over Berlin. Economists now feel the lull began to end several weeks ago.

> Recent good business news is adding strength to the earlier confidence in the soundness of this recovery. For example:
> -New orders for durables are the best in more than two years.
> -Personal income is rising and is now $15 billion over 1960.
> -Sales of 1962 autos...vital to all business...started strong.
> -Housing starts have finally turned and now top 1960 by 26%.
> Meanwhile, prices are stable and U.S. spending keeps rising.

ECONOMISTS ARE LIFTING THEIR ESTIMATES OF PROFITS, as one result of the business upturn. The sharp increases in productivity that normally come with a recovery are fattening margins--more so than many businessmen have been realizing. These days, $47 billion is considered fairly conservative for 1961--up $2 billion over 1960. Actually, earnings are doing better than this: In the fourth quarter alone, the rate will top $50 billion a year.

DON'T EXPECT ANY MAJOR TAX ACTION BY CONGRESS next year. During the session that just ended, the legislators were very cool to the package that Treasury officials had proposed. House tax-writers were especially hostile. So the Treasury plans to pull in its horns and ask for only a few changes. Only if these are voted--say, by April--would Kennedy seek broad revision.

> Big tax news of 1962 will be depreciation. Action may come as two fronts. The Treasury will continue to revise present rules, line after line; Secretary Dillon has promised this. Once industry's basic need is being met this way, business will be more receptive to Dillon's 8% credit for investment. And Congress will be sympathetic to industry's point of view.

THE TREASURY WILL COMPLETELY REVISE BULLETIN F, which prescribes the "useful lives" over which many items must be written off. The depreciation periods will be shortened, thus permitting quicker recovery of investment. Conceivably, the Canadian "bracket" system will be adopted--lumping many related items into a single group, with a common useful--and shorter--life.

> Efforts to up-date Bulletin F have been postponed for years by need for revenue. But now the need to spur modernizing--to make industry more competitive--is getting top priority. The revising will be a big, long job. So attention will go first to industries hardest pressed by foreign competition or those centered in areas of high unemployment. Before too long, though, it is hoped the benefits will reach all lines.

THE LEGISLATIVE TAX PACKAGE THE TREASURY WILL SUPPORT next year will call for some revenue-raisers to offset the income foregone by the proposed 8% tax credit against new investment. The most likely candidates are (1) new rules curbing expense accounts, (2) an end to deferring taxes on foreign-earned income kept abroad, and (3) withholding of dividends and interest.

INCOME TAX RATES WILL NOT BE CHANGED AT ALL--up or down--next year. Cuts are pretty much ruled out by the way the federal Budget keeps rising--mainly for defense. Rising costs even pose red ink in the next Budget year. On the other hand, Kennedy's economic advisers are dead against rate hikes. They fear that higher taxes could check or shorten the business recovery.

> The Keogh bill will die because of the concern over revenue. (This gives self-employed deductions for private pensions.) Backers will try to make the bill acceptable through changes. But Treasury men fear the $350 million-a-year loss involved. They make it clear they'll ask for a veto if the bill passes.

ELECTRONIC PROCESSING OF TAX RETURNS WILL BE INAUGURATED during 1962 by the Internal Revenue Service. Ultimately, every return will be handled. The Atlanta District will be the pilot area, with the system spreading out to other places at intervals. The system will start with returns of 1961. The Philadelphia area will probably be next--1962 returns handled in 1963.

> Business returns will be the first processed. The returns of individuals will be handled a year later in every case. IRS hopes to save time and manpower and catch more evaders.

Adhesive-Coated Copper Simplifies Production of Die-Stamped Circuits

One of the newer methods which lends itself particularly well to the mass production of printed circuits is that of die stamping. Basically, this process, licensed under patents of Resources and Facilities Corp., New York, N.Y., utilizes a heated die which cuts a conductive pattern from metal, and simultaneously heat-reactivates an adhesive which joins the metal to the insulating baseboard material.

One of the advantages claimed for die stamping lies in the fact that it is a "dry" technique which involves no chemical solutions which might impair the electrical properties of the baseboard material. This factor also makes it possible to use a far wider range of base materials—including thermosetting and thermoplastic materials, vulcanized fiber, and compressed paper or wood products—than is commonly used for etched circuits. Essentially, this means that a baseboard may now be selected on the basis of the desired electrical properties without the limitation of its chemical resistance.

It is also possible to use a somewhat wider range of conductor metals, while the metal used in etched circuits is usually limited to a maximum thickness of .0042 inch, thicknesses up to .015 inch have been used successfully in the die stamping process. Thus, designs for current-carrying capacity, a function of the volume of the conductor metal and the characteristics of the baseboard material, can accommodate in excess of 40 amps—about twice the normal limit for etched circuits.

Moreover, die stamping is a mechanical method which, once the die is prepared, insures consistent duplication of the circuit pattern and uniformity of configuration almost indefinitely. It also provides for extremely accurate registration as well as exact line definition with freedom from the potential hazards of line breaks or undercutting which can be caused by etchant attack.

Lower Costs

Whereas etched circuits depend almost entirely upon human skills for configuration and registration, the die-stamping process eliminates the painstaking and time-consuming hand operations. Because of this, it is possible to make accurately reproduceable, precision die-stamped circuits under mass production conditions at substantially lower cost. For example, it has been claimed that a die-stamped circuit consisting of comparable base material, conductor metal, tolerances, plating and finish, secondary operation, and quantity, can be provided for ten to 40 percent less than an etched circuit meeting the same general specifications.

Dytronics Incorporated, Rochester, Mich., is a large producer of die stamped circuits for a number of different industries. The following is a step-by-step description of how they produce a circuit which will become part of a missile assembly.

The most common of the conductor metals is copper, used here on a phenolic baseboard. To effect a further saving in production steps, Dytronics utilizes an adhesive-coated copper, developed and manufactured by Rubber & Asbestos Corp., Bloomfield, N.J.

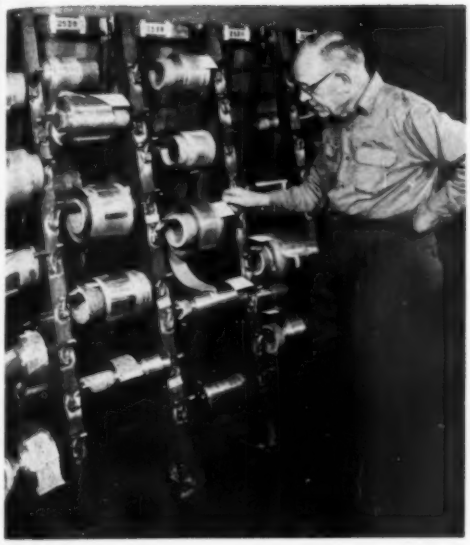
Known as Plymaster, this consists of copper foil already precleaned, pre-inspected for surface defects, coated with adhesive, and dried to a non-tacky state before it is shipped to the circuit manufacturer.

Since a typical stamping cycle is very fast (two to ten seconds dwell time at temperatures ranging from 350° to 440°F.), the adhesive which has been pre-coated on the copper is specially formulated to create a strong bond to the base material under such demanding conditions. It must also remain unaffected by the chemicals used for plating or finish.

Plymaster is supplied in rolls up to 60 inches wide and varying in length from 500 to 1000 feet, depending upon the weight or thickness of the copper. Dytronics slits these rolls into the various widths called for by specific circuit designs.

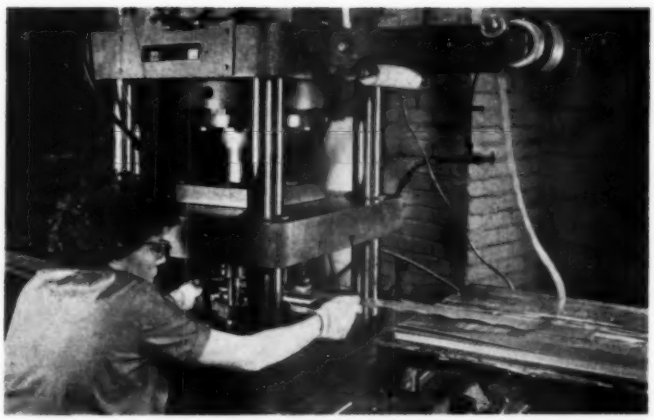
After the rolls are slit, they are given a plating bath. In this case, the adhesive-coated copper is run through a cyanide solution, a water rinse, a tank of lead and tin fluoroborate, and a final water rinse. This plating solder is used to promote better soldering of the component leads, terminals and hardware to the conductive pattern when the circuit board has been completed. Some critical circuit requirements demand plating of the copper with gold or silver for oxidation-resistance, or with rhodium for special wear-resistance characteristics.

After the plating process, the adhesive-coated copper is dried in a



After a four-step plating process, the slit widths of adhesive-coated copper are stored on special racks in a drying cabinet.

Stock sheets of the phenolic base material for the type of circuits shown being made in these photographs are cut to exact dimension.



Simultaneously fed strips of the phenolic base materials and of adhesive-coated copper enter the embossing press where heated dies stamp out the desired circuit pattern and bond the plated material to the baseboard.

Excess copper is stripped from the baseboard after the circuit pattern has been stamped and mounting holes made.

Circuits now receive a protective coating to prevent the copper from oxidizing. Next, strips will be cut up.

special cabinet and then stored on specially constructed racks according to width and type of plating. For the particular circuit being made in the production run shown in the accompanying photos, a phenolic base material is used. Stock sheets are cut to size and carefully checked for exactness of dimension.

The strips of phenolic base material and the adhesive-coated copper are next fed into the embossing press. Attached shears cut the copper to the same length as the base material as it goes into the machine. Here, the heated dies stamp out the circuit pattern and bond the adhesive-coated copper to the baseboard. Pressure on the dies varies, depending upon the hardness and temperature-sensitivity of the base meterial, die temperature, stamping time, and copper foil thickness.

During the stamping operation, pilot holes are also punched in the boards to insure accurate placement when they are pierced and blanked in a subsequent operation. These holes may also be utilized later as mounting holes after the circuit is fully assembled.

Stripping Excess Copper

Following the embossing operation, the excess copper is stripped from the base material.

At this stage, the strips of circuits receive a finish which is applied over the conductive pattern as an aid to soldering and/or for protection. The finish specified for these circuits is a water-dip lacquer which takes approximately five seconds to apply and will keep the copper foil from oxidizing. Epoxy or silicone resins, acrylic spray, or screened lacquer may also be used for this purpose.

Finally, the strips must be cut into individual circuit boards. In this step, the strips are first heated to approximately 300°F. and then blanked and pierced by machine in one operation. Separating the circuits may also be accomplished by sawing or shearing and the holes may be made in a separate operation by drilling or reaming, depending upon the specifications.

After the necessary testing and/or inspection are performed, the circuits are ready for shipment.

Pressure-Sensitive Surgical Tapes

Their History and Development

Most adhesives are applied in a liquid or semi-liquid form and are designed to wet out the surfaces involved. As the adhesive sets, its cohesion gradually increases from a low to a high value, eventually preventing the separation of the surfaces to be adhered. Both the physical and chemical characteristics of the adhesive and the surfaces play an important part in the bonding process.

However, the type of adhesive we are concerned with here shows no increase in cohesion after application, adhesion being achieved by the application of pressure only. This is known as pressure-sensitive adhesion.

Such an adhesive is spread as a thin coating onto a suitable sheeting (cloth, plastic films, paper or other material) as a carrier or backing, then cut into tapes of appropriate widths.

The two main classifications of pressure-sensitive tapes are industrial and surgical. However, since industrial tapes developed from adaptations and modifications of surgical tape, we shall concern ourselves only with the latter.

A predecessor of modern surgical adhesive tape (or plaster) was used in ancient times as a healing material applied to a local lesion and also as a means of holding a medicament to the skin. It is known that the Greeks made a substance known as "diachylon plaster" which was basically lead oleate formed by reacting olive oil and lead oxide, then washing out the glycerin. This formula was used without change for centuries until the mixture was supplemented by the addition of rosin and yellow beeswax in order to improve the tack of the plaster.

An important improvement came in the 19th Century with the introduction of rubber into adhesive plaster. This was the first adhesive which could be truly called "pressure-sensitive," since it adhered under pressure alone without application of solvent, moisture or heat. It was called rubber adhesive tape and is still in use for some purposes.

A typical rubber adhesive contained rubber, ordinary rosin and fillers such as starch or orris root. Near the turn of the century, zinc oxide was incorporated into adhesive plaster. This increased the adhesion and holding power of rubber-based adhesive masses.

Adhesive Composition

The standard surgical adhesive mass was composed of the following ingredients:

(1) Natural rubber, which was the basic elastomer and supplied the cohesive quality to the mass.

(2) Natural rosin which when combined with the rubber produced the pressure-sensitive quality.

(3) Zinc oxide, which was originally added for dermatological reasons. It was also found to have reinforcing properties which produced a superior adhesive.

(4) Starch or other inert fillers, which extended the mass and also tended to reduce excessive adhesion by virtue of their large particle size.

(5) Mineral oil or lanolin which acted as secondary tackifiers.

(6) Beeswax or other waxes which modified the adhesive strength and produced an easier unwind from the rolls.

This type of formulation had the

By MILTON H. KEMP
Arno Adhesive Tapes, Inc.
Michigan City, Indiana

Beginning with the "diachylon plasters" used by the ancient Greeks, the author surveys the industrial and chemical developments that have led to modern surgical tapes incorporating the newest synthetics

defect that the mass tended to dry out or lose its adhesive qualities because the ordinary rosin used was very oxidizable. The oxidizability of rosin may be illustrated by one of its main constituents, abietic acid, which contains two double bonds as shown in structural formula, Figure 1. When ordinary rosin is used in pressure-sensitive adhesive masses, it tends to oxidize, forming peroxides at the double bonds as illustrated in Figure 2.

Once rosin is oxidized it no longer forms a tacky compound with rubber. Also, it tends to catalyze the oxidation of the rubber itself, which changes from an elastic material to a very resinous substance. Thus, surgical tapes made with ordinary rosin eventually lost their tack and finally became brittle after one to three years depending upon formulation and storage conditions.

The first significant improvement came in 1934 when the first oxidation-resistant resin was introduced by the Hercules Powder Co. This was hydrogenated rosin, which is illustrated by dihydroabietic acid shown in structural formula Figure 3. The double bond shown may be in one of several possible positions.

Dihydro-abietic acid may be further hydrogenated to form tetrahydroabietic acid. However, it has been found that a degree of saturation somewhat over 50 per cent is sufficient to prevent the oxidation of rosin when used in tape.

Another modification of rosin also produced a product with lower oxidizability, namely dehydrogenated rosin. In this case, hydrogen is removed from the ring, to form three conjugated double bonds, or a true benzene ring. This type of rosin produced adhesive masses with very good aging qualities. As a result, tapes made with stabilized rosins retain their adhesive quality for many years.

Besides stable rosins, rubber antioxidants were sometimes used to prevent oxidation. These were also quite successful in improving the aging quality of tapes. However, the antioxidants had to be carefully evaluated in relation to skin irritation.

Wartime Development

The next major development came during World War II, when natural rubber was under strict allocation. Its use in surgical tapes was gradually reduced until finally it was prohibited altogether.

As the amount of rubber was reduced, various formulae were developed to produce adhesive masses with a lower rubber content. Substitute natural rubbers, such as balata, gutta percha, and quayule, which were not on allocation, were tried to replace part of the rubber. Also, formulae with high melting point resins and high filler contents were developed to extend the rubber. Partial cures with vulcanizing agents also were used to increase the cohesive quality of the rubber. This made it possible to use a very much lower percentage of rubber in the formulation.

However, these methods were largely stop-gap, for there was a tendency for the masses to be too firm and harsh. This quality seemed to produced a mechanical trauma which caused many complaints of skin irritation.

Besides reformulation to reduce the amount of natural rubber, work was carried out on synthetic elastomers for its complete replacement. Various types of butadiene-styrene rubbers were tried without too much success. At least some of the types produced severe allergic reactions.

Most of the experimentation was done with polyisobutylene elastomer, a saturated long chain molecule. The molecular weight range of the compound used for surgical tape was between 80,000 and 100,000.

Early work with polyisobutylene on plain cloth surgical tape was not very satisfactory because of the cold flow quality of the elastomer. The adhesive mass would flow into the backing, thus making the rolls difficult to unwind. Extensive research produced the answer to this problem. It was found that vulcanized oils (factice) would reduce the cold flow, and prevent excessive adhesion to the backing.

In the manufacture of such masses,

About the Author . . .

MILTON H. KEMP, vice president and research director of Arno, joined the company in 1945 and helped develop its industrial tape line.

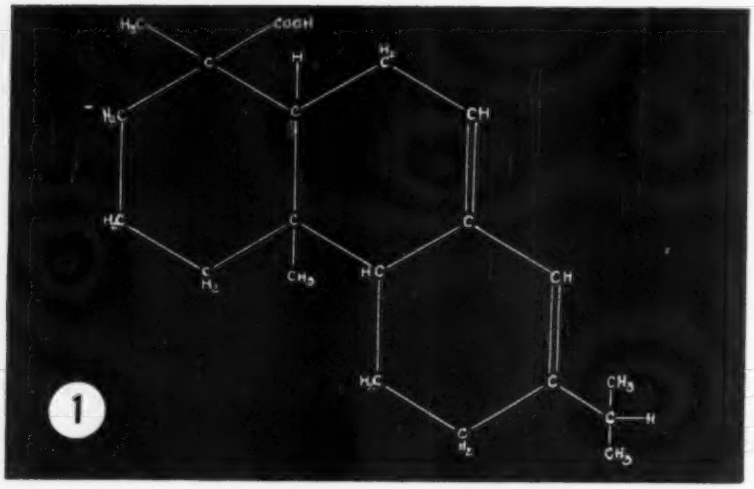


FIGURE 1—The oxidizability of rosin, illustrated by one of its main constituents, abietic acid, which contains two double bonds. Ordinary rosin tends to form peroxides. Once oxidized it no longer forms a tacky compound with rubber.

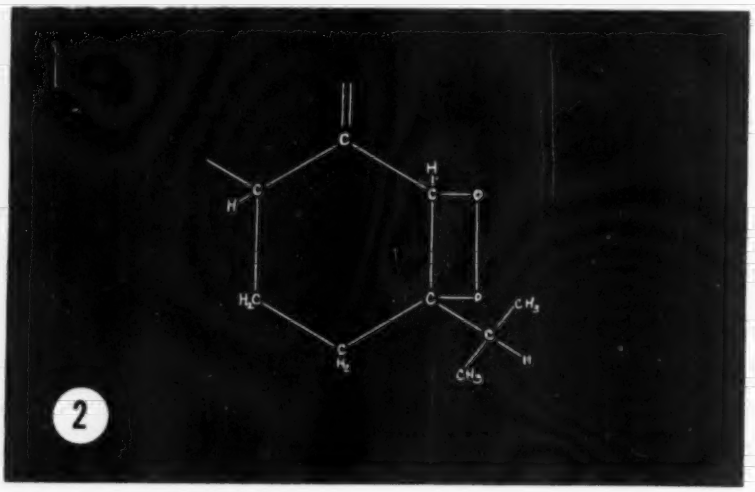


FIGURE 2—Illustration of how ordinary rosin used in pressure-sensitive adhesive masses oxidizes to form peroxides at the double bonds. It also tends to catalyze the oxidation of the rubber which converts from an elastic material to a resinous substance.

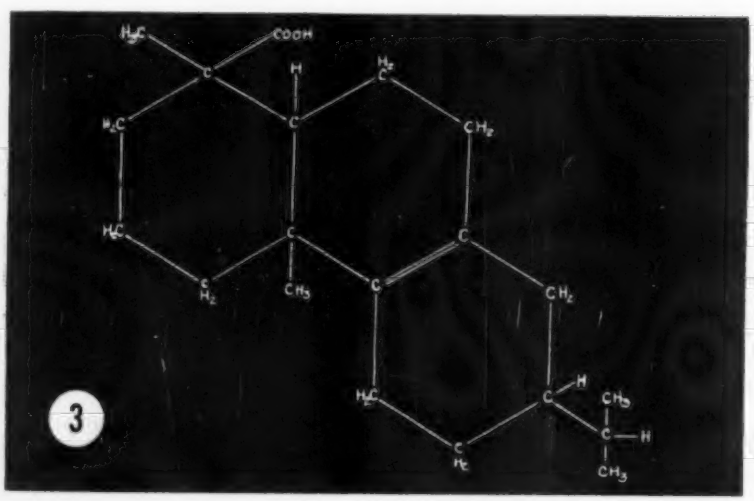


FIGURE 3—Hydrogenated rosin, illustrated by dihydroabietic acid. It represents a significant improvement first introduced in 1934. The double bond shown may be in one of several positions. This was the first oxidation-resistant resin.

the elastomer was processed on a rubber mill until it formed a smooth band. Factice was then added and worked in well. Then the other ingredients, such as resins, softeners and fillers, were added in a mixing procedure similar to that which was used with crude rubber. It was found that an ester resin, such as the glycerol ester of hydrogenated rosin, worked well in a polyisobutylene-factice mass. Also, tackifiers such as polybutene (3000 molecular weight) were used in addition to the resin.

Special Process

The most satisfactory factice for the purpose was Amberex B, which was made by a special process with a direct combination of sulfur with rapeseed oil. This material produced adhesive masses with very good physical qualities. The adhesives also had excellent aging properties. Samples stored for 15 years have been found to be still usable, although somewhat reduced in tack.

The present surgical adhesive tapes are still largely produced from these materials. However, masses incorporating newer synthetics such as certain acrylic polymers and polyvinyl aliphatic ethers are used for certain specialized surgical tapes. Clinical trials have shown these to be excellent in eliminating skin irritations, even for those cases allergic to standard surgical tape made with natural rubber.

Backings other than cloth also are used for surgical tapes, and their related products. For example, plastic films and non-woven fabrics are used for finger bandages and for surgical tapes.

Surgical tapes have been the basis for the outstanding development of the varied line of industrial tapes. Regular surgical tape was used for automobile paint masking before paper tape was developed for the purpose.

Modifications of surgical adhesive masses have been used on sealing, strapping, packaging and many other types of pressure-sensitive industrial tapes. Thus, the development of the surgical tape has given modern society a convenient, outstandingly useful tool for many varied applications.

To patch a vinyl-covered interior panel of a jetliner, workman applies a thin film of fast-setting adhesive, left. Exit light frame is bonded above door with only manual pressure.

Bonded Vinyl Patches

Jets' interior decorative vinyl fabrics are mended within a matter of minutes

Foreseeing the need of its customer airlines for rapid, on-the-spot repairs to the decorative vinyls used for interior decor on 707 and 720 jetliners, Boeing Airplane Company, Seattle, Wash., has developed an adhesive-based patch-repair process. The technique handles incidental damage in passenger cabins — a jab from a sharp-cornered piece of luggage, for example — which might otherwise require removing the airplane from service until its unmarred appearance was restored.

Deep-Textured Vinyl

Restoring the unblemished beauty of deep-textured decorative vinyl designs is not an easy task. The deep texture makes it impossible to feather out patching resin by sweeping. Mechanical external pressures, either clamping or vacuum, are usually impractical to apply in a completed airplane. Finally, speed in curing is an obviously major requirement in-service planes.

After some preliminary testing, Boeing engineers decided to base their patch-repair technique on a polymerizing cyanoacrylate monomer adhesive manufactured by Eastman Chemical Products, Inc., and designated as Eastman 910. Without heat or clamps, the adhesive can supply a fabric-tearing bond in a minute or less.

Mending Panels

Success in vinyl fabric repair led to use of the adhesive in mending holes in vinyl-aluminum bonded panels and for rebonding of polyvinyl chloride extrusions and molded parts used in passenger cabin interiors. The adhesive is also being utilized to advantage for bonding vinyl seals and fixtures around the doors of the jetliners.

All the bonding techniques developed are being made available to the airlines as a special customer service. Reports show that the resulting patches are often stronger than the original fabric.

The Shell sign and slogan were bonded to the enameled, semi-corrugated front of this California gas station with an epoxy adhesive formulation. Tests have shown that daily exposure to sun and rain will not affect the bond.

Plastic Letters Bonded to Metal Station Front

Gaptooth storefront signs with missing letters may become as extinct as the dodo due to a new high-strength adhesive system based on the same tough epoxy resins which join jet aircraft parts. The formulation is now being used to bond plastic and metal sign letters at Shell Oil Company stations in various parts of the country.

One of the most recent applications of the techniques was at the new Shell station in Walnut Creek, Calif., where the company name and selling message were bonded to enameled, semi-corrugated metal walls. The operation was completed by two workers in less than an hour.

The adhesive, Epon 907, is a two-part formulation included as part of a station sign package which contains the letters, paper, templates, cord lines, etc. It is a product of the Adhesives Department of Shell Chemical Co., Pittsburg, Calif. A non-sag, non-run formulation, it is said to bond sign letters of all types to metals, concrete, wood, masonry and other construction materials. Here's how it was used to mount the sign at the new Shell station.

Here's How

In the first step, the sign area was centralized and the blue cord lines that come with the kit were snapped into position. The paper template — stencilled in the exact size and spacing of the sign letters — was leveled to the lines and taped into place.

Next a "pounce bag" of charcoal powder was dabbed against the paper so that the powder passed through the stencilled perforations. When the template was removed, the metal surface beneath bore an outline image of the exact size and location of each letter in the sign.

To provide "tooth" for the epoxy, two-thirds of the surface area of each letter was then sanded with emery cloth. Next, positioning strips of wide masking tape were placed above and below the letter areas.

At this point the epoxy adhesive was prepared for use by mixing the premeasured resin and hardener in the resin container. A thin layer of the blend was then applied to the back of each letter. Because of the adhesive's strength, there was no need to cover the entire surface.

Since the surface on which the letters were to be bonded was corrugated, adhesive was spread on the area of letter contact. Wherever a major portion of a letter lay over an indentation, a small wooden block was first bonded in the space to provide an adequate anchoring surface.

As each letter was set into place, it was worked slightly into the adhesive to ensure proper contact. Then the masking tape was set over the top and bottom of the letter to prevent slipping during the adhesive cure. Three hours later the tape was removed and the job was over.

Epon Adhesive 907 has a workable life of 30 minutes at 75°F. Though it hardens in about three hours at 70° to 75°F., its peak strength of 3000 psi requires a 24-hour cure.

1 A paper template is set in place on the front and a "pounce bag" used to dab charcoal through the stencilled holes.

2 The glossy surface in letter areas is roughened with emery cloth to provide "tooth" for the epoxy adhesive.

3 The epoxy is prepared for use by mixing the premeasured parts of the resin and hardener in the container.

4 Because of the adhesive's high bond strength, only a few dabs of it are needed on the back of each letter.

5 Adhesive is spread on contact areas of the corrugated surface. Masking tapes prevent letter shift during the cure.

By WILLIAM M. DeCREASE

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Rubber-to-Metal Bonding: 1955-60

An examination of the changes in theory, processing, metal surface preparation, elastomer compounding and testing that have altered the industry picture

Organic adhesives have been used for bonding elastomers to metal for about twenty-five years. In early 1957, it was reported[1] that at that time brass plating accounted for about 20 per cent of bonded products made in the United States. About 60 per cent were made up of two-coat adhesive systems and only 20 per cent used a one-coat organic adhesive. In a 1960 publication[2], the same author reported a reduction in the use of brass plating to 15 per cent; the remaining 85 per cent of bonded parts was made with organic adhesives—55 per cent using a one-coat adhesive, and 30 per cent a two-coat system.

This increase in the use of one-coat adhesives is indicative of the dependability of present-day rubber-to-metal adhesives. The strength and the environmental resistance of rubber-to-metal assemblies made with organic adhesives have substantially improved since 1955.

The improvement in newer rubber-to-metal adhesives is due mainly to the increased emphasis on research by the suppliers of these materials. In order to be effective, adhesive development must parallel elastomer technology. For example, as the silicones and the fluro-elastomers, the urethanes, and the stereo-regulated elastomers become useful in applications where bonding them to metal is required, adhesives must be developed which, in addition to forming a strong union between the elastomer and the metal, will also resist any environment to which the elastomer may be exposed.

During the period 1955-1960, a new book[3] was published, *Adhesives Age* was established, numerous symposia and lectures were held, and a variety of technical publications, newsletters and supplier's bulletins covering the subject became available.

Only a portion of the developments reported can be reviewed in this article. Five general areas will be considered:

(1) Theoretical considerations
(2) Processing changes
(3) Metal surface preparation
(4) Elastomer compounding
(5) Testing

Theories of Rubber-to-Metal Bonding—One of the more complete presentations on the subject was published in 1955 by D. M. Alstadt[4]. He states, "For physical adhesion at the rubber-adhesive and adhesive-metal interfaces, it is important that the unjoined phases to be bonded demonstrate the maximum possible free surface energy compatible with a low interfacial free energy existent after bond formation. If adequate physical adhesion at either the rubber-adhesive or adhesive-metal interface is unlikely, chemical adhesion produced by the formation of primary valence bonds must be promoted."

He lists the properties of the elastomer, the adhesive, and the metal which are important in the formation of a rubber-to-metal bond.

The characteristics of an elastomer that are significant in bond formation are given as the polarity of the base polymer, the polarity changes in the rubber material induced by compounding or processing methods, the surface topography

About the Author . . .

WILLIAM M. DeCREASE is the supervisor of the Elastomers Section at Hughson Chemical Co. His responsibilities include research and development of adhesives for bonding elastomers to metals, textiles and other elastomers. His work on Chemlok 607 established him as an authority on silicone bonding.

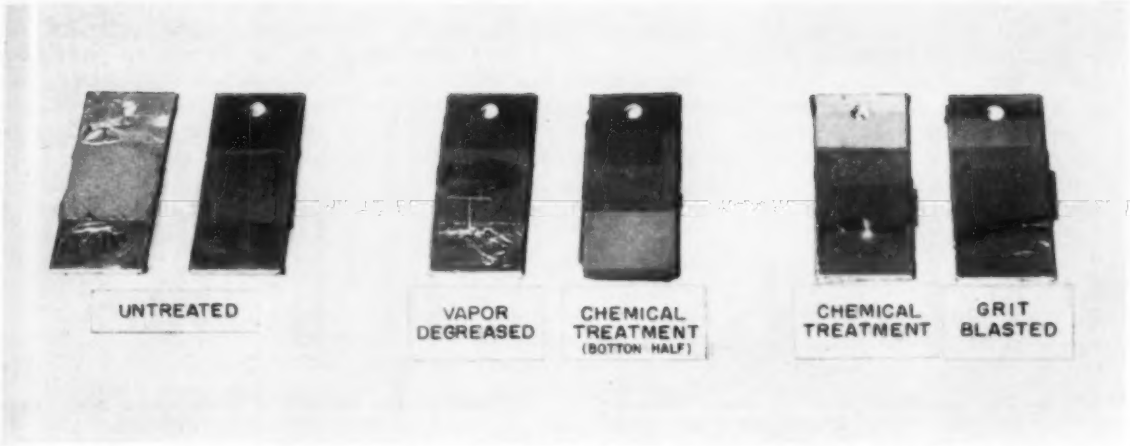

FIGURE 1—Treated and untreated destruction-tested specimens of silicone rubber bonded to aluminum. Most of the technical literature is in firm agreement that proper surface preparation is a "must" for high bond strength.

of the stock, the chemical reactivity of the rubber chains, and the nature of the interfacial electrical characteristics at the adhesive layer.

Factors relating to the nature of the adhesive system that are of importance are polymer polarity; the chemical reactivity of the polymer chain; the nature of chemical cross-bridging additives; the surface topography; the elasto-plastic nature of the adhesive; the molecular weight of the adhesive polymer; the homogeneity of the adhesive film; the solvent present in the adhesive system; the nature, concentration, and glavanic activity of reinforcing pigments; and the thermal expansion coefficient of the bonding agent.

The important qualities of a metal so far as adhesion is concerned are the thermodynamic free energy of the surface, the structure and thickness of natural or artificial absorbed films, the crystal orientation and free energy changes, and the surface roughness factor.

Refuting the concept of molecular or chemical adhesion were several publications by J. J. Bikerman. In these publications, he expanded upon his theory which maintains that a separation exactly along the interface between an adhesive and a substrate to which it is bonded (which he refers to as an adherend) practically never occurs, and consequently molecular adhesion is never measured when a bonded joint is broken by mechanical means. Bikerman's "rheological theory" claims that the presence of weak boundary layers in the adhesive, the adherend or the interface, prevents the formation of high strength bonds.

His experiments with polyethylene[5] were cited to support this hypothesis. By removal of substances (such as low molecular weight materials) by fractional precipitation, polyethylene was made "adhesionable."

Free Surface Energy

An intermediate position was taken by W. C. Wake[6] in 1959. He discussed the nature of an adhesive interface and the concept of free surface energy. In his article, Wake reviews some of the literature on the thermodynamic approach to adhesion, the importance of absorption in adhesive-adherend systems, and the roll of chemisorption in adhesion. He makes the interesting point that chemisorption may or may not occur in bonding depending upon the chemical nature of the adhesive and the substrates which are bonded. As one example where chemisorption plays a major roll, he refers to the bonding of hydroxyl containing polymers to metal oxide surfaces; whereas, the system involving the use of chlorinated rubber adhesives for rubber-to-metal bonding involves solely physical or van der Waals forces.

One of the leading proponents of the chemisorption school, John Rutzler, Jr., proposed in a 1958 publication[7] that the geometric arrangement of adhesive molecules on metal surfaces has a strong effect on the force between them. Rutzler, along with Dean Taylor, Jr., built scale models of high polymer molecules, placed the models over a scale drawing of the oxygen and metal ions of the surface of a metal and measured the maximum number of geometrically possible interactions between active sights. These investigators, of course, assumed some type of chemical interaction at the metal surface. By this approach, one should presumably be able to measure the maximum number of interactions in order to compute the adhesive force between a polymer and a metal and very likely between polymer and polymer.

In Russia, Deryagin and his associates at the Institute of Physical Chemistry, Academy of Sciences, have been studying the mechanism of adhesion for some time. In a 1956 publication,[8] Deryagin concluded that adhesion of rubbers is determined both by mechanical and diffusional properties. He further stated that the so-called electric double layer also probably influenced the adhesional shearing strength in some instances.

Deryagin in a more recent publication[9] takes a more positive stand in the direction of the chemical adhesion explanation. He suggests that the strength of a rubber-to-metal bond is determined by the intensity of the chemical interaction of the bonding agent at the inter-

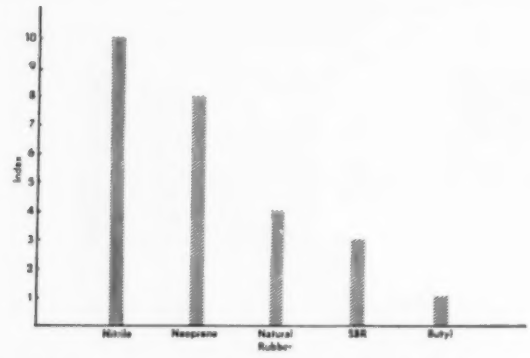

FIGURE 2—The "bondability index" of various elastomers. The higher the index, the more easily bonds are formed.

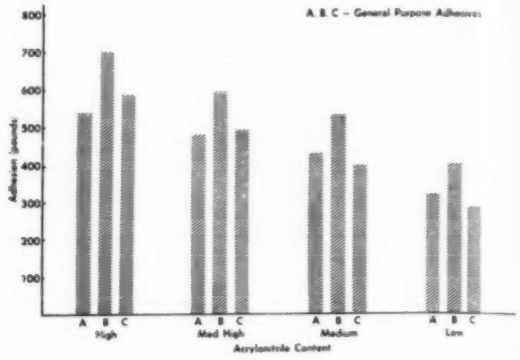

FIGURE 3—The adhesion of nitrile rubber bonded with different adhesives is improved by acrylonitrile.

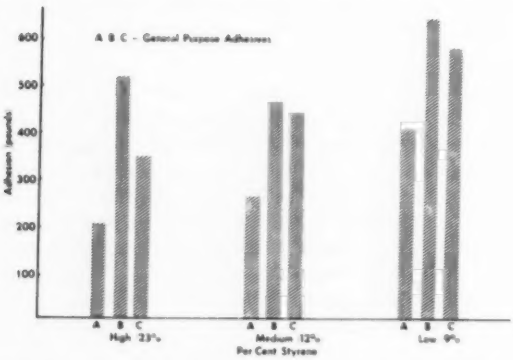

FIGURE 4—The adhesion of SBR compounds to metal is enhanced by low bound-styrene content.

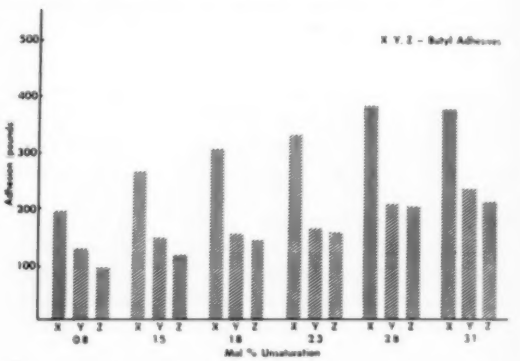

FIGURE 5—Higher unsaturated butyl polymers bond to metal more readily than those having less double bond.

face. He states that when the interaction intensity of the bonding agent film is approximately equal at the adhesive rubber, and the adhesive metal interface, bond strength is greatest. Where they differ sharply, the bond strength decreases.

In another paper on adhesion, S. S. Voyutskii[10] claims that the adhesion of dissimilar polymers is explained by the diffusion of chain-like molecules. Thus, in the case of bonding rubber to metal with an organic polymeric adhesive, diffusion between the adhesive and the rubber would be used by Voyutskii to explain bond formation. In this situation, he states that the duration of contact time between the adhesive and the substrate, the temperature, the molecular weight of the adhesive, its molecular shape and its polarity are important considerations.

It should be apparent at this point, that the controversy between the physical or rheological theory on one hand and the molecular or chemical theory on the other, has not yet been resolved.

My own exploration into the subject suggests that in uniting elastomers to metal with polymeric adhesives, a good bond can be made with or without the formation of primary chemical bonds between the substrates and the adhesives, but a high strength elastomer-metal bond is unlikely unless the rheological conditions are suitable. Furthermore, the benefit to be gained by chemical interaction is not an increase in bond strength but an improvement in the environmental resistance of the bonded unit at the interface.

Metal Preparation—In the published literature there are numerous points of dispute on various aspects of rubber-to-metal bonding. There is firm agreement, however, that a clean, properly prepared metal surface is a necessity for optimum bond strength. (Figure 1.)

During the five-year period that is the topic of this article, preference for the surface roughening by a blasting operation predominates. Thus, the preferred method in 1960 differs very little from that suggested five, or in fact fifteen, years ago—a degreasing operation followed by a grit blasting and then a second degreasing.

The use of chemical methods for preparing metal surfaces for bonding is, however, increasing. Phosphatizing is commonly used for treating steel. Stainless steel can be chemically treated either with acidic or alkaline systems. Aluminum may be treated by chromate or phosphate conversion coating processes; it may be anodized or, preferably, it may be coated with the new organic treatments which deposit a film by chemical combination with the aluminum surface.

The chrome pickle process is most often used on magnesium. Brass is usually treated either by the ammonium persulfate method or by the acid-ferric chloride process.

Chemical methods are not usually used on copper, lead, zinc, plated metals or casting alloys. This subject is more thoroughly discussed in Chemlok technical bulletin 7101, "Preparation of Substrates for Bonding."

Compounding—A recent publication entitled "Compounding Elastomers for Rubber-to-Metal Adhesion"[11] outlines some significant compounding considerations as they relate to rubber-to-metal bonding.

"Bondability Index"

In this paper, the concept of "bondability index" is introduced. This index is a convenient designation to describe the degree of bonding which, based on existing technology, can be anticipated in adhering the various elastomers to metal. The higher the index, the greater the ease of bond formation.

The bondability index given in terms of decreasing index is shown in Figure 2. This indexing may be carried through the compounding operation by assigning an index to compounding ingredients and thus one may predict the bonding ease of any elastomer compound.

The second point made in this article is that in copolymer elastomers such as nitrile, SBR and butyl elastomers, the concentration of monomers has a pronounced effect on adhesion to metal. Some specific examples are:

(a) Adhesion of nitrile rubber is improved by high acrylonitrile (Figure 3).

(b) When bonding SBR compounds to metal, adhesion is enhanced by low bound-styrene content (Figure 4).

(c) Higher unsaturated butyl polymers bond to metal with greater ease than those having less double bond. In other words, high isoprene butyl is favored (Figure 5).

Next the point is made that the sulfur modified neoprenes (such as the G-types) can be bonded with greater ease than the non-sulfur modified W-types.

In the area of the speciality elastomer, it is stated that the bonding of silicones, fluoro-rubbers, Hypalon, and to a lesser extent, urethane elastomers, is essentially independent of polymer modification.

It is also shown that when bonding blends of elastomers, especially those of very different bondability index, an adhesive should be used which would satisfactorily bond either elastomer when used alone.

On the subject of bonding an oil-extended SBR compound to metal, the point is made that best results may be obtained by compounding a naphthenic oil into an SBR polymer containing no more than 25 parts oil. Further, it is noted that the ester type or the highly aromatic plasticizers are more harmful to adhesion than are naphthenic or parfinic types. It is also noted that the bondability index of an elastomer may be substantially increased by the addition of certain fillers, such as channel blacks.

Moving further into the subject of the compounding ingredients, the following specific suggestions were made:

(1) The elastopar content in butyl rubber should be kept below 1 phr. and ideally below 0.5 phr.

(2) Copper Inhibitor Number 65 in Viton is detrimental to adhesion. LD-214 may be used instead.

(3) An increase of from 11 to 13 phr. of MOCA in compounding Adiprene will enhance adhesion to metal.

(4) The use of stannous chloride as an activator for resin-cure butyl may reduce the bond to metal. Hypalon activation is preferred.

(5) Gasing or blowing in silicone rubber must be minimized for proper adhesion to metal.

Conclusions Drawn

This article concludes with the comment that although the principles listed appear to be valid for all rubber-to-metal adhesives, they are less pronounced when an adhesive of a versatile nature is used where changes in compounding are better tolerated.

Processing Rubber - to - Metal Bonded Parts—Mainly because of the improvements in the newer ad-

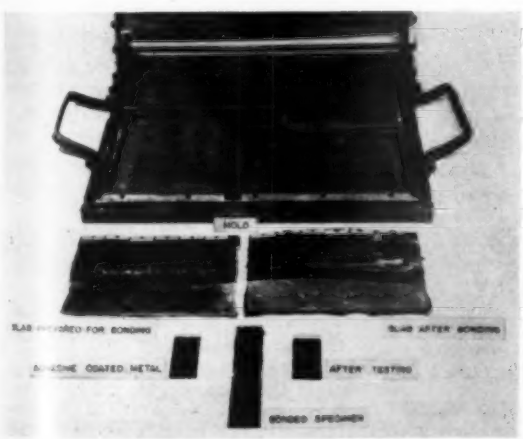

FIGURE 6—The 90° peel test for rubber-to-metal bonds described in ASTM Test D-429-56T-Method B.

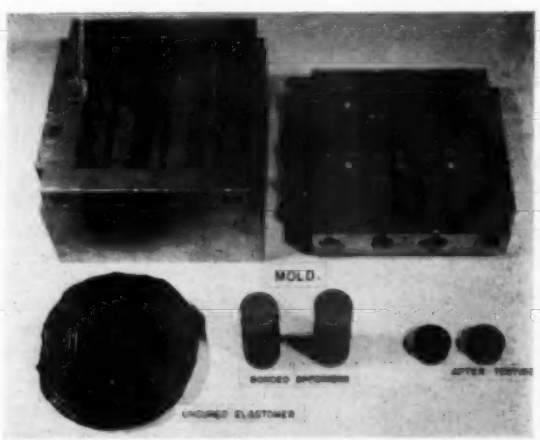

FIGURE 7—Testing rubber-to-metal adhesion by the conical method which was developed by G. W. Painter.

hesives, processing of rubber-to-metal bonded units has become more systematic and less laborious. In general, present day adhesives are not sensitive to humidity, pre-heating, sweeping, and similar conditions.

The user of rubber-to-metal adhesives now finds his process much easier to control. Adhesive-coated metal parts can often be permitted to stand for long periods of time before bonding; they may be pre-baked if desirable, or pre-heated in a mold, if necessary. They are resistant to hot tear and thus can withstand rough handling required for removal from a mold. The need for scrupulously clean metal parts which was commonplace some years ago is no longer the case, although cleanliness is still emphasized. Compounding changes may make a difference in adhesion, but present day adhesives resist these changes much more effectively than did their predecessors. In addition, because scrap losses are reduced, the use of adhesives has resulted in significant cost reductions.

Testing Rubber-to-Metal Bonds—During this five-year period, the 90° peel test (Figure 6) described in ASTM Test D-429-56T-Method B has come into common practice as a convenient and fairly reliable means of evaluating rubber-to-metal bond strength. Another benefit to be gained by this method is the ease with which the method lends itself to environmental resistance study.

The need for a meaningful dynamic adhesion test was still apparent and was not satisfied during this five-year period. Probably the most significant development in testing was the emergence of a new test method developed by G. W. Painter[12].

This method utilizes conical metal surfaces to which rubber is bonded in order to make the test specimen (Figure 7). The most important characteristic of this unit is the tendency of the conical specimen to fail at the bond rather than in the body of the elastomer, even when adhesion is excellent. This apparently results from stress concentration in the vicinity of the bond. As the specimen is stressed by pulling the conical metal parts away from each other, failure begins at the points of the cones and progresses down along the sides until it is complete.

This rubber-to-metal bond evaluation technique differs from those now in use in several important respects:

(a) In contrast to other rubber-to-metal adhesion tests, failure due to stress during testing occurs in the bond interface rather than within the body of the elastomer, as is often the case in the peel tests. When failure occurs within the elastomer body, all that may be concluded is that adhesion is in excess of the tear strength of the elastomer under the test conditions. A forced interface failure, as is the case with this new conical technique, permits comparative evaluation in this area of fair to excellent adhesion. Thus, greater reliance may be placed on the results—the actual number of pounds—as a measure of the bond strength of a rubber-to-metal system.

(b) This method has shown greater reproducibility than any of the rubber-to-metal adhesion tests now in use.

(c) A close cluster of results between replicate samples is the rule rather than the exception. This is often not the case with the butt joint or peel tests.

These factors make possible a reliable comparison of rubber-to-metal adhesion where more confidence may reasonably be placed on the degree of differences which often occur in practice. This new method will probably be very valuable to the adhesive user who must often make a choice of several adhesives, all of which appear to have equal adhesion to a variety of elastomers.

It seems fitting to conclude this discussion by doing an about face and looking ahead an equal period of time in an attempt to predict important developments during the next five years.

To prognosticate is always hazardous. New developments in the polymer sciences may invalidate extrapolations based on today's knowledge. I would expect, however, further refinements in the areas which we have discussed. Industry will demand new adhesives which are more versatile, less costly and even more dependable.

The service requirements for rubber-to-metal adhesives will be elevated; in particular, resistance to high temperatures, corrosive environments, and organic liquids can be expected.

The range of cure temperatures for processing bonded units will very likely be expanded. The introduction of liquid urethane elastomers has already brought cure temperatures as low as 212°F. Increased production rates, on the other hand, have increased cure temperatures to 370°F., and, in some instances, even higher. In the case of some of the specialty elastomers, post-cure requirements are as high as 500°F.

We will also probably see brass plating essentially disappear from the rubber-to-metal bonding scene and be replaced with organic adhesives.

Bonding castable elastomers, room-temperature curing elastomers, and vulcanized elastomers to metal will present new challanges.

It is my hope that during this period continued effort will more clearly define the mechanism of rubber-to-metal bonding so that the adhesive supplier can more successfully fulfil his obligations to industry.

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Thermosetting Adhesive "Freezes" Rail Joints of Crane Runways

An experiment with adhesive-reinforced bolted crane rail joints is being carried out at the Bethlehem Steel Company's plant in Bethlehem, Penna., in an attempt to restrict the movement inherent in conventionally bolted joints.

The adhesive — a formulation identified as Bondarc and manufactured by Armstrong Cork Co., Lancaster, Penna. — is applied to the mating surfaces between the joint bars and the rails. Once the assembly has been bolted together, the adhesive cures to form a "frozen" rail-joint bond which aids in reducing the longitudinal separation or gap that can occur between the rail ends.

Battered Running Surfaces

In a conventionally bolted joint, the "wear and seating" at the adjoining rail and bar surfaces permits movement of the rail ends under traffic. This process, aided by the forces of expansion and contraction, leads to battering and spalling of the running surface at the rail ends. The result is high maintenance costs and limited crane rail life.

The adhesive process described was employed in the two crane runway locations at Bethlehem to study this approach toward continuous rails which would nevertheless retain the flexibility inherent in bolted track.

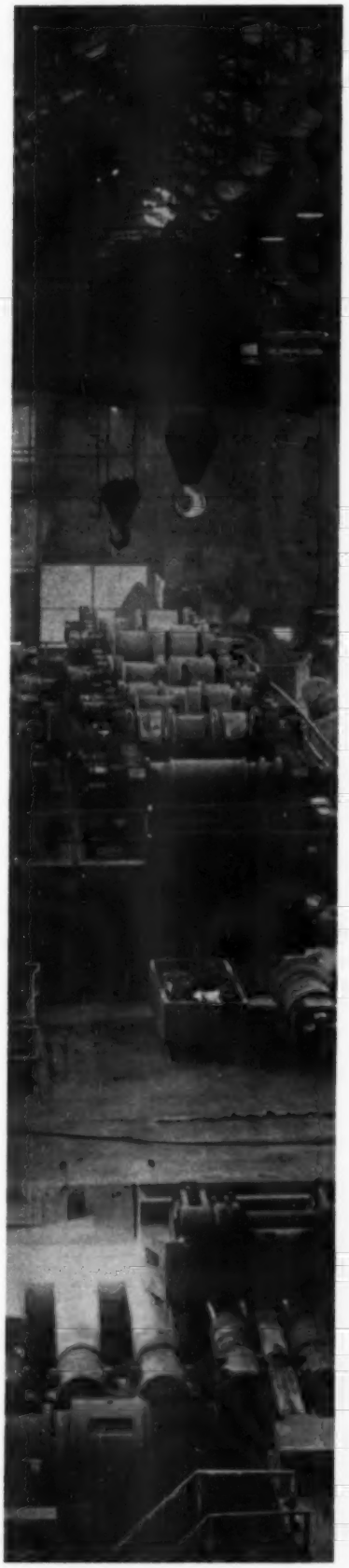
In mid-February 1960, worn 100-pound rails were replaced on a 420-foot runway that has two 50-ton cranes. The replacement sections were 60-foot lengths of 104-pound CR fully heat-treated crane rails. They were both bonded and bolted into place. All rail ends and splice bars were sand blasted before being adhesive-spread.

While the previous rails, conventionally joined, became battered at the rail ends, the new installation appears to be working satisfactorily. The only signs of wear are hairline cracks on the top of the joint bars at three of the 12 joints.

In another test at the plant, a foundry runway was reinforced and worn crane rails replaced. In June 1960, all the joints were re-made using the adhesive method developed. As with the first installation, the rail ends and splice bars were sand blasted prior to applying the adhesive.

In all, there are 14 joints on these rails which carry one 40-ton crane, three 25-ton cranes and one ten-ton crane. With the exception of hairline cracks on the top of the splice bars of three joints, the installation is performing creditably. Time and service will indicate the merits of this manner of assembling crane rail joints.

The Bondarc adhesive used is a thermosetting formulation that is mixed on the spot. It will cure at normal air temperatures, but a faster cure can be obtained with heat.



Rail joints of this 420-foot track for two 50-ton cranes are "frozen" in position with a thermosetting adhesive.

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Lap Shear and Creep Performance in Metal-to-Metal Bonds

From a wide variety of research in the field of adhesive bonding carried out in Germany[1-5] during recent years, two particular problems are presented.[6] Since this investigation puts special emphasis on room-temperature curing adhesives as opposed to the heat-curing adhesives most commonly used as structural adhesives in this country, the examination of the results presented here may prove useful for field repair of aircraft and missiles or other special applications.

Effect of Adhesive Young's Modulus on Stress Distribution in the Glueline — According to analyses of the stress distribution in the glueline of lap shear bonds as reflected in the literature[7&8] stress and strain of the adhesive are assumed to be in linear relation similar to the behavior of most metals. This simplifies the mathematical treatment. However, the stress-strain curve of plastics is non-linear in many cases even at small stresses in the elastic range.

Since adhesives belong to the same category of materials, the same characteristic can be expected. This was demonstrated by an investigation of six types of cast film adhesives, one of which was of a heat-curing type and five ambient-temperature curing. In Figure 1, three

Figure 1 — Young's Modulus Versus Stress of Cast Film Adhesive

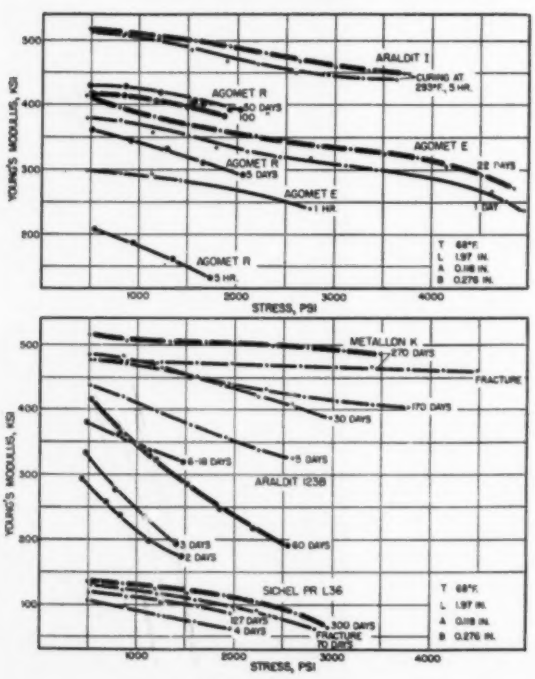
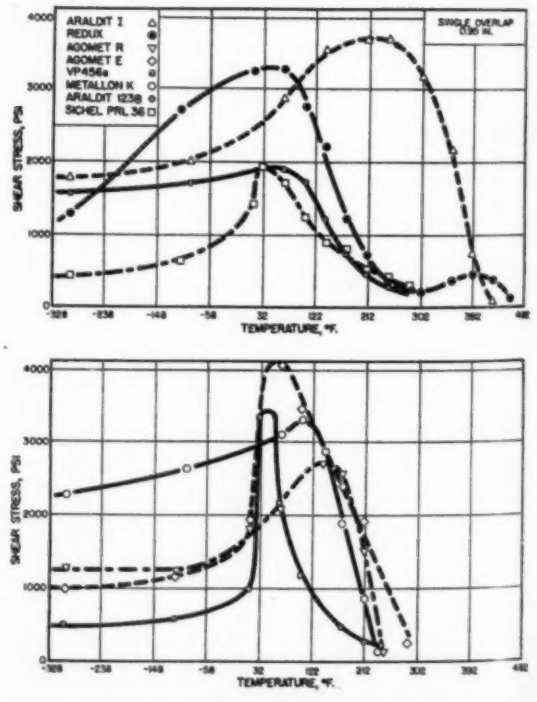


Figure 2 — Shear Stress Versus Temperature for Eight Adhesives



distinct types of behavior can be observed:

(a) The Young's Modulus decreases linearly with increasing stress until the failure of the specimen (see Araldite I, Metallon K, Agomet K).

(b) The Young's Modulus decreases rapidly at low stresses but decreases more slowly at higher stresses (see Araldite 123B), and

(c) The Young's Modulus decreases slightly at low stresses but decreases more rapidly as stress increases (see Agomet E, Sichel PRL 36). In the last case, there exists a smooth transition from the "elastic" into the "plastic" portion of the stress-strain curve.

The non-linearity of the stress-strain relation can also be demonstrated by testing the adhesive in butt joints as has been done by Norris[9]. The type of joint used in Norris' work prevents contraction of the adhesive perpendicular to the direction of the acting force. The two-dimensional stress condition thereby created contributes to the extended linear stress-strain relation at low stresses.

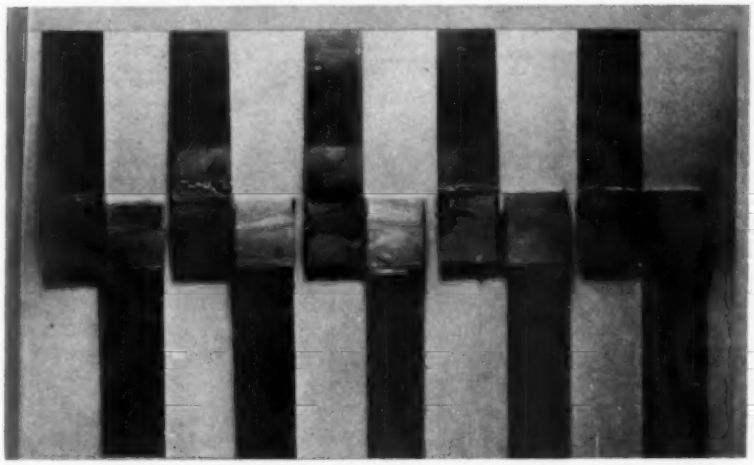
The non-linearity of stress and strain of the adhesives causes the actual peak stresses in the glueline of a lap joint to be lower than the stresses calculated using the linear stress-strain relation. Furthermore, for an adhesive to really equalize the stress distribution in a lap joint, it must have a particular stress-strain relationship.

The strain in the adherend of a lap shear specimen decreases from a distinct high value from where it enters the overlap to zero at the other end.

For the following consideration, it is of secondary interest how this decrease occurs, as long as this changing strain consistently produces nearly the same amount of stress in the adjacent glueline. This implies that a high strain does not produce much more stress in the glueline than the lower strain.

An adhesive meeting this requirement must have a stress-strain relation with a rapid increase of stress at low strain: that is, a high modulus of elasticity. Also, the stress-strain curve must have a curvature in its elastic portion to cause a lower rate of stress increase with increasing strain. This results in a smoother transition between the "elastic" and the "plastic" portion of the stress-strain curve. The modulus of elasticity of such a material decreases at an accelerating rate as the stress increases.

Figure 3 — Adhesive Remainders on Broken Specimens



Note: Test temperatures (left to right) 68°F., 104°F., 140°F., 176°F., 212°F.

Effect of Temperature

The influence of temperature on the strength of lap joints is shown in Figure 2. The slope of the temperature versus shear-strength curve for lap joints at room-temperature is used for comparison with changes in Young's modulus and the tensile strength at the same temperature for cast adhesive film specimens.

Young's modulus —E— and tensile strength —σ— of the cast film adhesive specimens decline as test temperatures increase. This helps to explain the increase in lap shear strength with a temperature rise for bonds with long overlaps. Therefore, the increasing temperature prevents pronounced stress peaks at the ends of the overlap. Hence, the specimen can support greater total loads.

An increase in lap shear strength at elevated test temperatures over that at room temperature occurs with Araldit 1, Metallon K, and Agomet R (Figure 2). The E-σ relationship for these adhesives at room temperature (Figure 1) possesses a very small slope compared to the same relationship for the other adhesives shown. These small slopes can be increased by increasing temperatures.

The slope of the E-σ relationship indicates the degree of stress relief that can be expected in a lap shear bond.

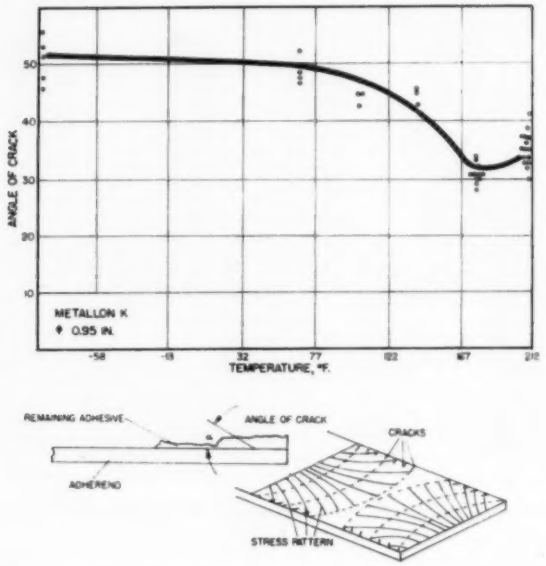
Araldit 123 B produces the most rapidly declining E-σ relationship at room temperature (Figure 1). This E-σ relationship does not appear to change appreciably with lower temperatures, according to the data in the low-temperature shear strength diagram (Figure 2).

Since Araldit 123 B cannot have a slope much steeper than shown in Figure 2, its lap shear strength cannot be expected to increase with a higher test temperature.

The shorter the length of overlap, the more even is the stress distribution in the glueline. This stress distribution is more comparable to a butt joint, therefore, the smaller overlap decreases the influence of stress distribution on lap shear strength. Bending due to the offset of the forces from the center line of the adherends is not considered here.

Further evidence of the effects of a stress distribution in a lap shear bond can be obtained from the examination of the ruptured specimens (Figure 3).

Figure 4 — Bias of Adhesive Cracks Versus Temperature



At low temperatures, fracture is caused by the simultaneous propagation of cracks at both ends of the overlap which enter the joint at interfaces of the sections of the adherends subjected to the greatest strain. This divides the adhesive layer at the center of the joint with approximately half remaining on each adherend. At high test temperatures, where the strain taking capability of the adhesives increase, the fracture occurs simultaneously over the entire area of the overlap. This fracture is characterized by the lack of this definite division of the adhesive at the center of the overlap.

Lap Joint Cracks

Certain adhesives produce cracks in the fractured area of a lap joint. The specific arrangement of these cracks gives additional information on the stress distribution in the glueline (Figure 4). These cracks have a characteristic angle to the surface of the bond. If this angel is compared at various test temperatures, a change has been observed at the middle of the length of overlap.

Since an increase in temperature and an increase in stress affects the Young's modulus of an adhesive in the same way, it can be deduced that the stress distribution in a glue-line is a function of the amount of applied stress. This conclusion is in agreement with the previously mentioned results.

Creep Behavior — The relative displacement of two creeping adherends of a lap joint was measured by means of a mirror-knife-edge device used for measuring tensile elongation in metals. Seven different adhesives (two heat and five room-temperature curing) were investigated to determine the effect of the following variables on creep: Length of overlap, type of overlap (single, double), load, glue-line thickness, test temperature, and degree of polymerization. A long overlap, approximately one inch (24 mm), was chosen because it reflects the significance of the influencing variables more pronounced than a short overlap.

From the above listed variables the effect of degree of polymerization will be discussed here.

Six specimens made from Araldit 123 B, a room-temperature curing epoxy, were bonded under identical conditions. After assembling they were cured at room-temperature for periods of 4½, 5½, 6½, 14, 25, and 60 days before exposure to creep loads. The elongation was plotted against curing time.

One curve was obtained by measuring creep data after one minute of load time, another curve was made for creep at failure. A third curve was made for the total time of load exposure until failure — called lifetime—and plotted against curing time. Examination of the curves (Figure 5) shows changes are most rapid between the fifth and the eighth day. Further changes can be observed up to 60 days but they are very small and decreasing in magnitude.

The relation of elongation versus time plotted on a log-log chart turned out to be practically linear.

The slope of the elongation versus time curve is also influenced by the degree of cure. In a log-log plot a straight line can be expressed as: $y = at_n$. In this equation, y = the elongation, a = a constant, t = time, and n = the slope of the plot.

If we assume a small value of n indicating a small 'creep velocity," and a large value of n indicating a high "creep velocity," it can be seen that the creep rate has its greatest change in the lifetime curve.

The creep rate slows down during this time, apparently as a result of continuing polymerization producing a high number of new cross linkages. This does not conflict with the fact that there is a large amount of total creep of the adherends at failure.

Polymerization Effects

The polymerization effects observed in an adhesive used in a glue-line also appear in a cast adhesive film specimen when mechanically loaded (Figure 1). All investigated room-temperature curing adhesives exhibit a change in the "Young's Modulus versus stress" curves as a result of continuing polymerization. Besides the increase of Young's modulus during the polymerization period. Araldit 123 B, also shows a decreasing slope between the third and the sixth day in all curves.

The above results, obtained from small specimens, cannot be quantitatively extrapolated to full scale production assemblies. Therefore,

Figure 5 — Creep, Lifetime and Creep Rate of Lap Joints Versus Curing Condition of Adhesive

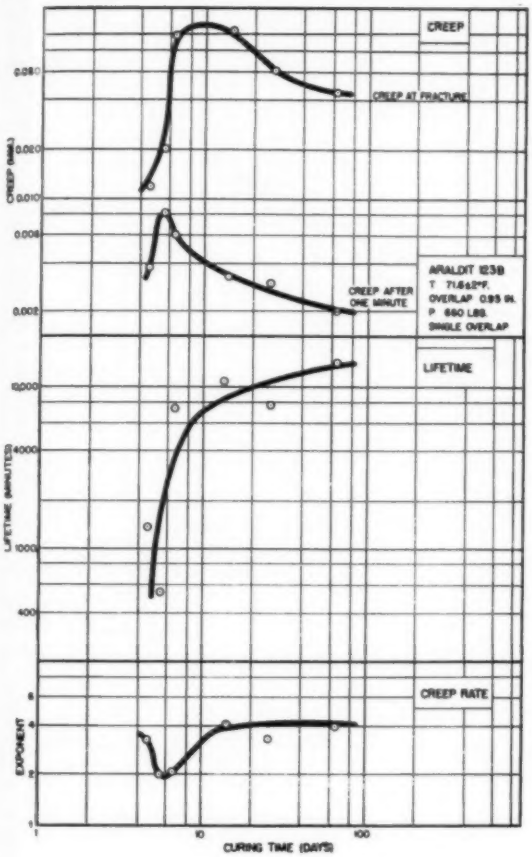


Figure 6 — Creep of Adhesive-Bonded Aluminum Beam

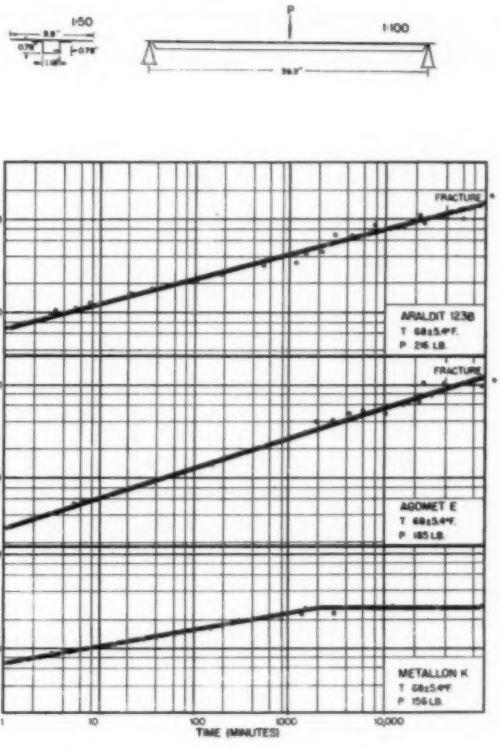


Figure 7—Creep of Lap Joints as affected by Different Glueline Thickness

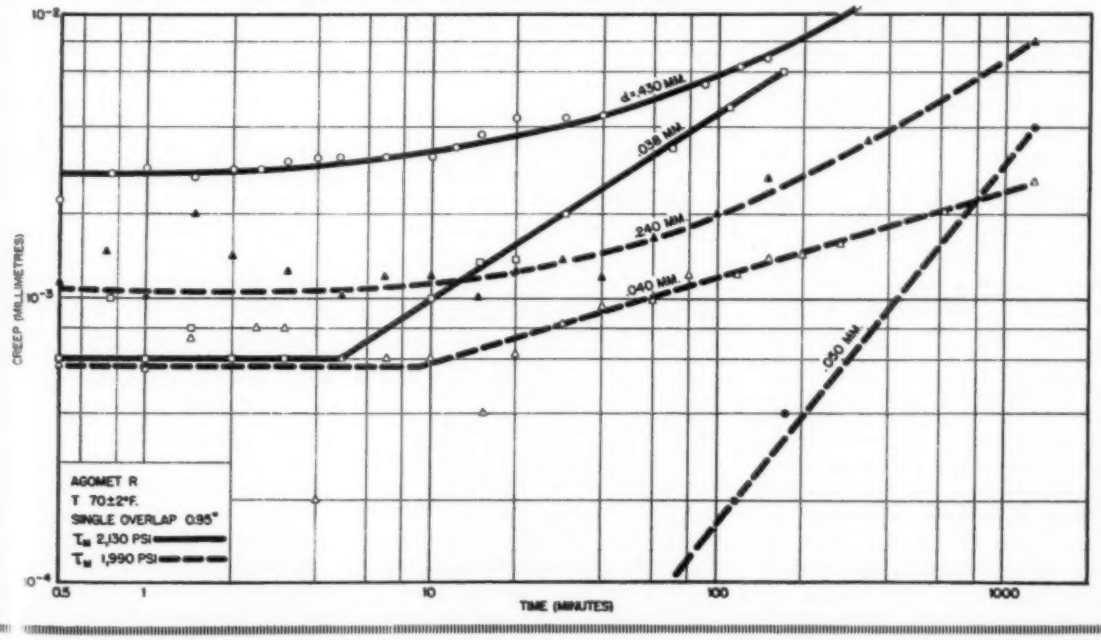
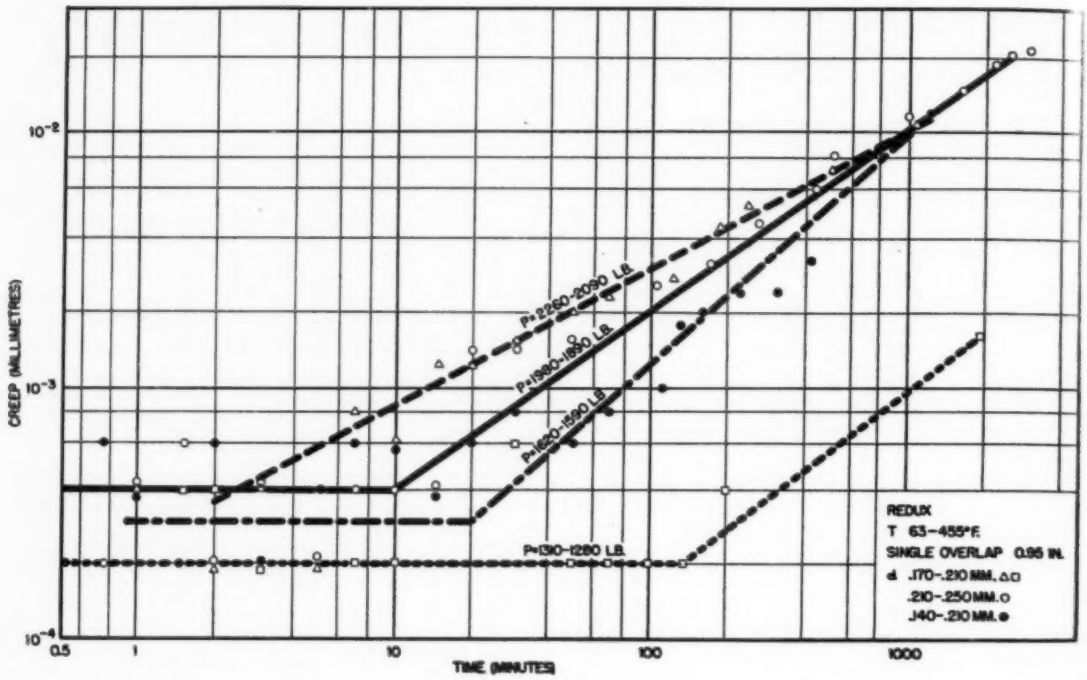


Figure 8 — Creep of Lap Joints as Affected by Various Loads



sheet-metal beams were subjected to creep loads. They were assembled from 0.06-inch thick aluminum six inches wide and 39 inches long, and a single hat profile stringer bonded to the center of the sheet by means of three different room-temperature curing adhesives.

The beam was simply supported at its ends outside the joint in order to subject the end of the joint to high peel loads. After load application, the mid-span deflection was measured as shown in Figure 6. The results indicate that creep has to be expected under certain conditions in full scale bonded structures and that creep in these cases follows the same time law as observed from small lap joints.

The creep of lap shear bonds with different glueline thicknesses subjected to the same external load is represented in Figure 7. Figure 8 shows creep caused by different external loads. In this case, the gluelines of all specimens were practically equal. Both plots exhibit the following peculiar phenomenon: In the case of glueline variation (Figure 7), creep starts spontaneously in thin gluelines after a certain time lapse. In case of load variation for normal glueline thicknesses, a smaller external load also causes a delay in the start of creep (Figure 8).

Cast Adhesive Films

In both Figure 7 and Figure 8, the curve following the sudden start is different from that of the thicker glueline and the higher load, respectively. Cast adhesive film specimens tested under different load and temperature conditions did not show this behavior. Therefore, the unique behavior of the curves is independent of the type of adhesive and is apparently a function of the condition of the joint only.

The following explanation of the above observations is based on the stress distribution in a glueline of a simple lap joint exhibiting higher values at the end of the overlap than in the center:

In the glueline of heavily loaded lap joints, the peak stress at the end and the minimum stress in the center of the overlap are so high that creep starts immediately. At lower loads, a large portion of the external load will be transferred at the ends of the overlap but only for a short time after application of the load. The center part of the overlap during this time is subjected to very little strain; therefore, it transmits the remaining part of the load without creep.

Tests on cast adhesive films showed an increasing amount of creep as the loads increased; simultaneously, they exhibited a faster decrease in the rate of creep. Therefore, the creep rate in a lap shear bond will decrease most rapidly at the end of the overlap and more slowly towards the center.

In addition, the total strain imposed on the adhesive stays unchanged while the resulting stress peaks get smaller. Under a constant external load the sum of all stresses along the glueline will remain constant. Consequently, the stresses in

the middle of the overlap will increase when the maximum stresses at the end of the overlap drop. This increased adhesive stress in the center portion of the overlap will also result in an increase of strain at the same location (Figure 9).

The decrease of stresses in plastics subjected to a finite deformation is related to its relaxation characteristics. This stress relaxation follows an exponential time function which makes it appear rapid immediately after load application. Therefore, the higher external load (Figure 8) causes the discontinuity in the curve after a shorter time lapse. The time lapse between load application and beginning of creep is expected to be a function of the relaxation time of the adhesive. Thus, the stress distribution in the glueline is changing with time. Stresses in gluelines, therefore, can be understood only as momentary values immediately after load application.

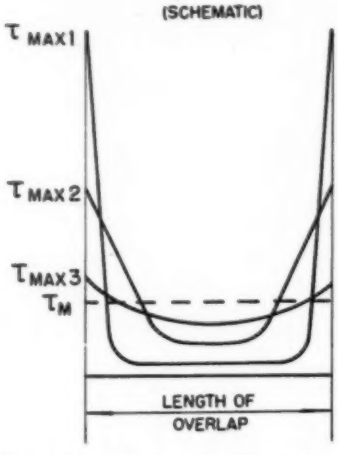
The same explanation applies when thin gluelines are exposed to creep.

Stress and strain in the adherend outside bond area shall be considered to be equal in the case of two identical bonds which differ only in the glueline thickness. At the end of the overlap—not in the entire area—the thin adhesive layer will be forced to a greater strain than the thick one (Figure 10). This amounts to a higher stress which will transfer a relatively greater part of the external load at this part of the bond. The geometry of the bond and the stress-strain relation of the adhesive are the principal influencing factors.

The change occuring with the lapse of time is principally the same in this case as compared to the condition of different loads: decreasing of the peak stresses and simultaneously increasing of the minimum stress; the mean shear stress remains unchanged.

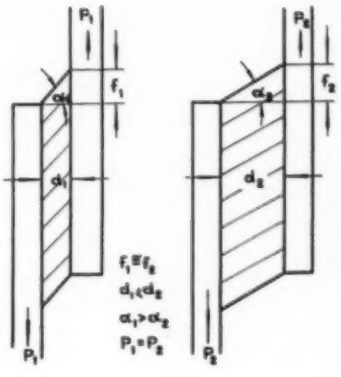
The higher creep rate starting after the discontinuity of the curve (Figure 7 and Figure 8), is the result of the previous mechanical treatment of the adhesive. Following the severe relaxation at the end of the overlap, these parts of the adhesive will be able to transmit higher stresses only if they were forced to a certain high strain. Therefore, the total displacement of the adherends, after creep becomes measurable, is not sufficient to contribute the necessary amount of stress.

Figure 9—Stress Pattern as Affected by Relaxation Time of Adhesive at Constant External Load



Note: T_{Max1}, T_{Max2}, T_{Max3}, maximum stress at end of overlap at three different times. T_M, Average shear stress.

Figure 10 — Adhesive Displacement at Overlap End, Identical External Load, Different Glueline Thickness



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About the Author . . .

KARL F. HAHN received his MS and Ph.D. degrees in mechanical engineering at the Technische Hochschule, Hannover, Germany, where he was also an assistant professor before he joined Douglas as a research engineer. He is the author of several papers on adhesive bonding.

NEWS of the

ADHESIVES WORLD

Five Papers on Adhesives Presented at Packaging Forum

Five papers were presented at an Adhesion Seminar held on October 20, 1961, during the 23rd Annual National Packaging Forum of the Packaging Institute at the Hotel Biltmore in New York City. F. C. Palmero (Johnson & Johnson) served as chairman of the Adhesion Seminar, and the papers presented were: "Starch and Dextrine Adhesives — Past, Present and Future" by Vincent M. Smith (American Adhesives); "Resin Adhesives for Straight Line Gluing" by Edward J. Murray (Morningstar-Paisley); "New Developments in Synthetic Resin Hot Melt Adhesives" by Robert S. Forsyth (National Starch & Chemical); "A Food Processor Looks at Adhesion Problems" by W. Tate Hutchins (Kroger Co.); and "Important Factors in Carton Sealing" by Richard J. Nadasky (Personal Products).

Bag and Carton Sealing

The first speaker, Mr. Smith, traced the development of adhesives used in bag and carton sealing. While covering tapioca and potato starches in a general way, his main emphasis was on corn starches and dextrines made by the wet milling process. He described the methods of manufacture and discussed each of the various types of starches, modified and unmodified, and dextrines. The particular characteristics of these adhesives, as they pertain to sealing, were investigated, as well as the types of applications.

Mr. Smith, who is chief chemist for American Adhesives, did not go deeply into the technical aspects of starch chemistry, but rather concentrated on the practical aspects of these materials and their use in the packaging industry.

Type of Equipment

Mr. Murray, development group leader at M-P, discussed the relation of resin adhesives to the type of equipment used in straight line gluing operations. He related the adhesive properties to physical requirements, such as compression time, formation of carton, etc. The type of board covered by Mr. Murray, in conjunction with various coatings, included bending chip, news vat lined chip, single manila, bleached manila, patent coated, clay coated, solid bleached, and sulfate.

The speaker also discussed the advantages of resin adhesives over other types, as well as the problems encountered with the board and the adhesives. Mr. Murray presented a program for mutual cooperation of board manufacturer, adhesive manufacturer, and converter.

Hot Melt Adhesives

The third speaker, Mr. Forsyth stated that the packaging industry is showing increased interest in synthetic hot melt adhesives. According to the senior chemist at National Starch, part of this interest is based on the inherent advantages of a hot melt, such as adhesion to difficult surfaces and almost instantaneous setting speed.

In addition, the speaker pointed out that new technical developments in the formulation and application of these types of adhesives has encouraged users to try and take advantage of the properties of resin hot melts. Mr. Forsyth also reviewed some of the new technical developments and discussed why it has taken so long for the full potential of hot melt adhesives to be realized.

Mr. Hutchins, the fourth speaker, who is a package technologist for the Kroger Co., asked and answered some of the following questions:

how a food producer looks at label adhesion to glass problems; what type of specifications for packaging materials are necessary to assure him of proper raw materials he can reasonably expect to maintain; how much technical assistance he feels his suppliers should supply in setting up and maintaining specifications; what he sees to be the responsibility of his suppliers of glass, labels, adhesives, and machinery to him; what he finds to be some of the common causes of label failure and what can be done to overcome them; and how he feels suppliers should cooperate with each other and with him in finding solutions to his problems.

Important Factors

Mr. Nadasky, packaging process engineer at Personal Products Corp., the final speaker at the Adhesion Seminar, stated that factors of prime importance in carton sealing efficiency are the relationship of absorbency and scoring to adhesive performance. He explained that an attempt was made to establish absorbency norms when a questionnaire resulting in the Packaging Institute Advisory Service Report No. 322 was circulated.

According to the speaker, the answers to this questionnaire indicated some agreement. He pointed out that it was apparent, however, that the requirements of the carton users were dictated more by individual requirements, such as machine, product packaged, humidity, etc., than by general industry needs. In his remarks, Mr. Nadasky defined a procedure to determine these individual requirements, and discussed various tests to ascertain absorbency and scoring efficiency.

Nuodex Appoints Two

The appointment of William J. Houston as executive vice-president and Dr. H. W. Schultze as technical director has been announced by Nuodex Products Division of Heyden Newport Chemical Corp., New York, N.Y. Mr. Houston was previously vice-president in charge of marketing for the division while Dr. Schultze was manager, Catalysts, for the division.

Standing at podium, F. C. Palermo (Johnson & Johnson), chairman of the Packaging Institute Adhesion Seminar, makes his opening remarks. The panel of speakers, seated left to right, are: Robert S. Forsyth (National Starch & Chemical); Edward J. Murray (Morningstar-Paisley); W. Tate Hutchins (Kroger Co.); and Richard J. Nadasky (Personal Products). Not shown: Vincent M. Smith (American Adhesives).

Murray Heads Research

Cordo Chemical Corp., Norwalk, Conn., has appointed Dr. Charles A. Murray as director of research, thermo-setting plastics. He will be located at the laboratories of the company's Mobile Plastics Division, Mobile, Alabama. Dr. Murray received his B.S. degree in chemical engineering from Purdue University in 1934, and his Ph.D. from the University of Michigan in 1940. Before joining Cordo Chemical on a full-time basis, he had previously served as a consultant on the company's technical staff developing specific resin system projects. Author of a number of papers on the subjects of surface chemistry and coating materials, Dr. Murray has spent many years in the development and application of resinous materials in the plastics and coating fields.

Borden Promotes Dill

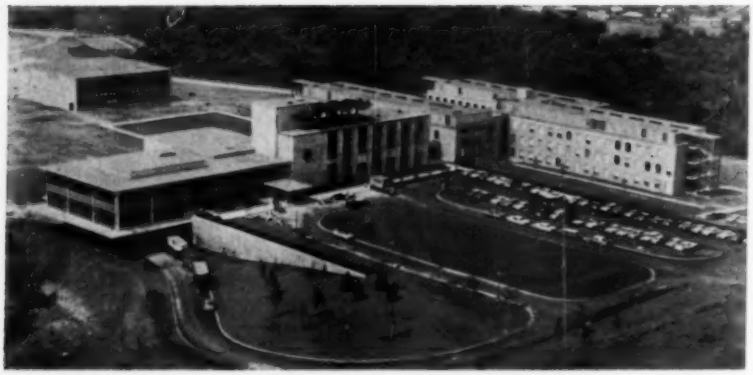
Borden Chemical Co., New York, N.Y., has appointed Joseph R. Dill as vice-president in charge of administration. In his new capacity, Mr. Dill will be responsible for coordinating personnel as well as for legal, traffic and purchasing functions of the firm. He will also continue as controller of the company, a post he has held since 1959.

Hodag Chemical Expands

Hodag Chemical Corp., Skokie, Ill., has completed a new two-level building and installation of new automatic equipment which will double the firm's production of surface active chemicals. The equipment includes a 1,000-gallon, electrically heated reactor with an automatic control system. The building which houses this reactor and its auxiliary equipment is also designed to accommodate additional processing systems in the future. The company stated that the new facilities represent the third major plant expansion in a continuing program of planned company growth.

European Firm Formed

A new Belgian company, Binks International S.A., has been registered in Brussels with Binks Manufacturing Co., Chicago, Ill. as one of its chief stockholders. The new firm will manufacture spraying equipment and intermediate products. The new company has a capital of $250,000. Partners with the Chicago firm in this enterprise are the Brussels firm, Etablissements Daniel Doyen S.A. The Belgian firm has, until now, specialized in the market development for British and German automobile equipment.



An aerial view of the principal construction now completed at the new Research Center of the Koppers Co. in Somervell Park, Monroeville, Penna. Koppers operates eight other research and development facilities of varying sizes where product and process control, application research, and pilot plant operations are the principal activities.

Koppers Opens New Research Center

Koppers Co., Pittsburgh, Penna., has dedicated its new $8.5 million Research Center at Somervell Park, Monroeville, Penna. The new facilities, said to be one of the most advanced of its kind in the country, will become the headquarters of Koppers' Research Department. The center is designed to handle the research needs of the firm for the next 40 years, and will eventually house over 1,500 scientists, about four times its initial population. Only about one-third of the buildings planned for the 176-acre site have been completed; a construction schedule for the remaining buildings has not yet been set.

The new center consists, at present, of a five-story administration building, three 3-story interconnecting laboratory wings, and several outlying auxiliary buildings. The company has provided for future expansion by installing glass enclosed stairways at the end of each wing, which can be removed when additions are called for and reaffixed to the end of the new wing.

Among the divisions to use the new research facilities will be the Resins and Adhesives Group of the Chemicals and Dyestuffs Research Section. This is the group responsible for the introduction of resorcinol-formaldehyde resins and adhesives called Penacolites. At present, the principal use of these resins is in formulating room temperature or fast-curing adhesives for laminating timber beams or bonding tire cords. The group has recently developed a new adhesive particularly suited for bonding Douglas fir in the 40° to 60° F. range. In addition, the group is developing butadiene-dipoxide resins, as well as other types of epoxy resins.

Plastics Division Sold

Minnesota Mining & Manufacturing Co., St. Paul, Minn., is selling its Zenith Plastics Division, Gardena, Calif., to H. I. Thompson Fiber Glass Co., Los Angeles. Thompson is purchasing the plant in a plan to expand the firm's southern California facilities for aerospace industry products. Terms of the sale have not been disclosed by the company.

Consumers Adds Grout

A new tile grout, suitable for repairing cracks and breaks around tubs, showers, and basins, and for filling seams between wall and floor tile has been added to the line of 40 building products manufactured by Consumers Glue Co., St. Louis, Mo. The new tile grout, which is white, is available in one pound packages, five pound packages and in 25 pound bags.

Dow Chemical Net O f

Dow Chemical Co. reports a new high in sales but a substantial decline in earnings for the fiscal year ended May 31. Net earnings for the period amounted to $64,439,878, equal to $2.23 per share, compared with $82.4 million for the previous fiscal year — $84.3 million if adjusted for the earnings of Allied Laboratories, acquired December 31, 1960. Sales totaled $817,514,653. The company attributes its lower earnings to higher manpower costs, continued price attrition, and increase in depreciation of $10.8 million (depreciation was at an all-time high of $89.8 million), and heavy expenditures involved in the introduction of new consumer products.

Sales revenues were derived approximately 51 per cent from chemicals, 35 per cent from plastics and 7 per cent each from metals and agricultural chemicals. The company reported expenditures of $148 million on capital additions during the year, as compared with $102 million in fiscal 1960. It estimated that it would invest about $100 million in property additions during the current fiscal year.

Stein-Hall Profits Decline

Stein, Hall & Co., Inc., New York, N.Y., reports that sales and earnings for the six months ended June 30 showed a decrease compared with the first half of 1960. Sales were off slightly, amounting to $28,976,506 for the current period, compared with $29,755,165 a year ago. Earnings for the first half were $430,465, equal to 57¢ per share, against $563,291, or 75¢ per share, for the first six months of 1960. The company attributed the decline, in part, to increased costs of doing business in 1961, including an increase in its technical and sales staffs.

• A polyethylene emulsion of exceptionally high concentration has been developed by Valchem, the Chemical Division of United Merchants & Manufacturers, Inc. The new product, Valsof PE-45 is now in production at Valchem's Langley, S.C. plant.

Metro Adhesives Formed

Metro Adhesives, Inc., North Bergen, N.J., has been formed as an affiliate of Hudson Industries Corp., whose Hudson Glue Division produces animal glues at its plant in Hudson, N.Y. The new company will manufacture a complete line of adhesives, as well as provide technical service for the bookbinding, packaging, paper converting and general laminating industries.

Harry S. Eldridge, formerly technical director of United Paste & Glue Co., has been appointed vice-president in charge of product development and manufacturing. Mr. Eldridge will provide technical service for Metro customers. Julian Wolfenstein, formerly with the Borden Chemical Co. and American Polymer Corp., has been appointed sales manager.

Pyles Opens Branch

Pyles Industries, Inc., Detroit, Mich., manufacturers of metering and dispensing equipment for adhesives, has opened Eastern branch offices at Iselin, N.J. David R. Davis, formerly Pyles' Eastern regional manager, has been named to manage the office which will cover the Eastern New York, Eastern Pennsylvania, New Jersey, Deleware, Maryland, and Virginia territories. This new branch will carry a complete stock of components and parts for all Pyles' equipment and will enable Pyles to provide customers in the Eastern part of the United States with advisory and consultation services.

Enlarges Tape Laboratory

Professional Tape Co., Riverside, Ill., has added 13,000 square feet of laboratory and productive space to its existing 8,000-square-foot facility. A specialist in the field of proper labeling procedures for both the medical and industrial market, Professional Tape has enlarged its facilities for the scientific development and research of tape and labeling procedures to combat infectious diseases that attach themselves to laboratory and hospital personnel through self inoculation. The new plant building will have the capacity to handle over 20,000 accounts, the company reports.

Stix Introduces Pom Pom

Stix Products, Inc., New York, N.Y., has added a new pattern to its line of self-adhesive plastic coverings. The new design is a floral pattern called Pom Pom, available in 18-inch widths, in predominating shades of yellow, lavender, or pink. The self-adhesive plastic will cover any smooth, dry, clean surface, according to the company, from shelves, cabinets, and splash areas, to complete walls, according to the company.

Hand Tape Applicator

Velvet Touch Corp., Bellingham, Wash., has marketed a tape applicator with a special single handed action that allows the applicator to roll out the tape to the desired length. The action is simply a tilt and a twist and the tape cuts itself off. Labeled the "Velvet Touch", the applicator is designed to eliminate waste, wrinkling or curling. It holds any ½-inch wide, one inch core tape, masking, vinyl, or cellophane, the company states.

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Quantum Names Fogarty

John C. Fogarty has been named sales manager of Quantum, Inc., Wallingford, Conn. Mr. Fogarty was formerly a sales representative for Warner-Chilcott Laboratories. In his new position, Mr. Fogarty will have charge of research projects to fit the technical needs of Quantum's industrial clients, the negotiation of research contracts, and the licensing of patents to products and processes held by the laboratory.

Price Promoted

John V. Price has been named assistant to the manager of the Midwest Adhesive Division, Stein, Hall & Co., Chicago, Ill. Mr. Price, who has been with the firm since 1954 in the Atlanta, Ga. office, is a graduate of Ohio State University. He formerly was sales manager of Atlanta Box Co. The company also announced that LeRoy Johns had been named to succeed Mr. Price as an adhesive sales representative in the Atlanta office.

Improving PVA Adhesives

A new technique for improving the properties of polyvinyl alcohol type adhesives was described at the recently held 6th Annual Technical Conference of Minerals & Chemicals Philipp Corp., Menlo Park, N.J. Research chemists of the Air Reduction Chemical & Carbide Co., New York, N.Y., addressing the group of MCP distributors and sales representatives, indicated that the technique imparts a high degree of wet tack to the adhesive and speeds its setting time. Essentially, the method incorporates a water-soluble boron compound which is cooked into the adhesive; the boron acts with polyvinyl alcohol systems much as borox does with dextrin adhesives. The final product is held within restricted limits of pH to produce high tack rather than high viscosity. Formulations containing Air Reduction's Vinol polyvinyl alcohol are being applied with MCP's aluminum silicate pigments for use in solid fiber laminations, spiral and convolute type tubes, and boxes.

Low Viscosity Resins

Two high-purity vinyl solution resins with high solubility characteristics are being marketed by Union Carbide Plastics Co., New York, N.Y. Intended for the preparation of product finishes and industrial maintenance coatings, the resins, Bakelite VYHD and VXCC, are medium molecular-weight, vinyl chloride-vinyl acetate copolymers. VYHD is unmodified; VXCC is structurally modified to impart metal-adhesion properties. Coupled with good toughness, flexibility and chemical resistance, the key property of both resins is their low viscosity in solutions of high solids content.

Pioneer Acquires Hasco

Pioneer Plastics Corp., Sanford, Me., has purchased Hasco Plywood Corp., St. Albans, N.Y., distributor of plastic products. The purchase reportedly was made for cash, but further details of the acquisition were not disclosed. Hasco has annual sales of about $3,250,000, which would bring Pioneer Plastics' annual sales to nearly $15,000,000.

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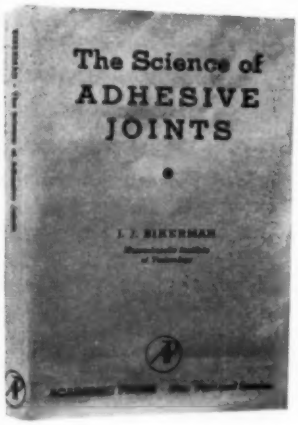

The Science of
ADHESIVE JOINTS

By J. J. BIKERMAN

Supervisor of the Adhesives Laboratory
Massachusetts Institute of Technology

240 pp. Illustrated 5¼ x 8¼ in. $8.00

This book is an authoritative presentation of the basic scientific knowledge of adhesive joints. Both the physico-chemical and the mechanical (or rheological) aspects of the problem are discussed in detail. A chapter for the practicing technician, which stresses the industrial importance of adhesive joints, is included. This chapter, like the entire volume, is based on scientific theory; no easy recipe for adhesive formulation is attempted.

The art of making adhesive bonds is older than are physics and chemistry, and, as the author states, a large number of disconnected ideas, rules and traditions has been accumulated by the many generations familiar with adhesives. In this work, the chaff is removed and the grains exposed.

The new science of adhesive joints is eminently practical, but it has to be intelligently applied to bring practical results. Therefore, no ready-made formulations for producing adhesives or adhesive joints are included. The last chapter does spell out how the new science should be put into practical use. The use of the term "adhint" is used as an abbreviation for "adhesive joint."

This is an important book for all those engaged in research and development related to the manufacture or utilization of adhesives.

TABLE OF CONTENTS

Solid Surfaces: Why Adhesives Are Needed; Transition Layers Rather than Surfaces; Surface Roughness; Numerical Data on Surface Roughness; Surface Porosity; Variability Across the Surface; Gas Absorption; Absorption from Solutions.

Adhesives and Other Joints: True Adhesive Joints.

Formation of Adhesive Joints: Wetting; Measurement of Contact Angles; Hysteresis of Wetting; Rate of Wetting and Removal of Air; Pretreatment of Adherend Surfaces.

Tack

Setting: Physical Formation of Weak Boundary Layers; Frozen Stresses; Weak Boundary Layers of Physico-Chemical Origin; Weak Boundary Layers of Chemical Origin; Flaws in the Bulk of the Adhesive; Time of Set.

Final Strength of Adhints: Improbability of True Adhesional Failures; Final Strength of Proper Joints.

Stresses in Adhints: Butt Joints; Lap Joints; Peeling.

Experimental Strength of Adhints: Adhints of Different Types; Strength and Dimensions of an Adhint; Strength of Adhints and Adhesives; Strength of Adhints and Composition of Adhesives; Rate of Loading and of Rupture; Effect of Temperature; Effect of Environment.

Tests and Summary for the Practical Man

Author and Subject Indexes

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Ammonia Unit Planned

Swift & Co., Chicago, Ill., has joined with the Skelly Oil Co. in making plans for a $10 million ammonia and nitrogen products plant at Clinton, Iowa. The two firms have formed Hawkeye Chemical Co., which will build and operate the unit. Capacity of the plant will be 300 tons of ammonia daily. Part of this output will be marketed and the balance used to produce nitric acid, nitrate solutions, ammonium nitrate, urea and nitrogen solutions.

Swift has also announced the consolidation of its industrial chemical operations into a single department which will handle soap and soap chemicals, technical products, fatty acids and other fat-based chemicals. This consolidation of what was formerly four separate departments follows the recent start-up of additional industrial chemical facilities at the company's technical products plant in Hammond, Ind. George H. Hallenbeck, previously in charge of soap and soap chemical operations, has been named manager of the new department.

Carpet Latex Developed

Lotol L-4634-D, a self curing latex compound for carpet backing, has been developed by Naugatuck Chemical Division, U.S. Rubber Co., Naugatuck, Conn. The compound is said to require one half the amount of thickner used in standard compounds. In addition, it has good heat and light-ageing characteristics. It also has excellent low-temperature properties and high filler tolerance. The compound was specifically developed to enable carpet manufacturers to achieve additional economies during the backing operation. By requiring less thickening agents, and having a greater tolerance to filler materials, the new compound permits measurable savings.

• A new chart showing at a glance all of the approved uses of each specially denatured alcohol formula has been issued by the Industrial Chemicals Department of Commercial Solvents Corp., 260 Madison Ave., New York, N.Y.

Studies Labeling Practices

The Packaging Institute, Inc., New York, N.Y., has formed a task committee to deal with the problems brought to light at the recent Senate Committee Hearings on Packaging and Labeling Practices. Lloyd Stouffer, editor of *Modern Packaging* magazine and a director of the Institute, has been named as chairman of the task committee, which includes representatives of leading national companies. The board of directors of the Packaging Institute has approved the following statement of policy: "The Packaging Institute . . . is the only national organization representing the interests of all packagers. As such, we feel it is our responsibility to . . . draw up recommendations to the appropriate government regulatory bodies to eliminate the confusion and ambiguities in the present regulations regarding content statements and other aspects of packaging which can be misunderstood by the consumer."

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Offers Casting Compound

A shrink-proof liquid casting compound which reportedly can be cast to almost any thickness or size, and is suitable for both solid casting and hollow slush molding has been introduced by Allen Plastics Corp., New York, N.Y. The new compound, designated Alplex, can be cast in rubber, plaster or wood molds, and is said to yield strong, perfectly-detailed castings which are waterproof and resistant to heat, solvents and weather. Alplex is a 100 per cent solids compound which requires no heating or cooling, and which permits removal of cast objects from their molds within ten to twenty minutes. Objects can also be cast in a range of colors by adding Alplex Liquid Pigment to the compound, and may be painted or decorated with a variety of finishes. It is recommended for making museum reproductions, models, garden ornaments, lamp bases and tooling.

Forms Flexicraft-Wrapture

Spencer Chemical Co., Kansas City, Mo., has merged two of its recently-acquired suppliers of flexible packaging materials into a single concern, to be known as Flexicraft-Wrapture, Inc. The two companies were formerly known as Flexicraft Industries, Inc.. New York, N.Y., and Wrapture, Inc., Flushing, N.Y. Wrapture, Spencer's more recent acquisition, buys plastic film such as polvethylene, cellophane, acetate, foils, laminates and other synthetic flexible packaging materials, and converts them into printed bags and roll stock for packaging end-uses. The newly-formed company will operate as a subsidiary of Spencer Chemical.

Hexcel Earnings Rise

Hexcel Products, Inc., Berkeley, Calif., has reported that net earnings for the first nine months ended September 30, 1961, were 46¢ per share compared to 27¢ for a like period in 1960. The company also announced that sales for the nine months of 1961 were $4,711,302, an increase of $35,238 over a 1960 figure of $4,676,064.

Coating Resists Corrosion

Chemical Fire & Rust Proofing Corp., Great Neck, L.I., N.Y., has developed a sprayed-on, glass-reinforced, polyester coating, said to offer increased and more economical protection against chemical corrosion. Use of the spraying technique is said to provide a protective coating in approximately 50 per cent less time than hand layup work with glass fabric or ceramic tile application. In addition, the company states, the relative homogeneity of the spray-on coating has greater resistance to corrosion, while providing a uniform coat, in thicknesses ranging from 1/16 to ⅛-inch, even in irregular and inaccessible areas where a layup coating is difficult to apply. The manufacturer also reports that the continuous film of reinforced polyester provides a smooth, unbroken surface, more impervious to corrosion than more expensive materials. The spray-coating technique is suggested for use on processing equipment in the paper, chemical, petroleum, textile and other industries.

Polyfoamstix Developed

A new adhesive for bonding Ethafoam, a product of Dow Chemical, has been developed by the research laboratory of Adhesive Products Corp., New York, N.Y. The product, designated Polyfoamstix, bonds Ethafoam polyethylene foam to itself, wood, glass, metals and plastics. Polyfoamstix has excellent aging qualities and good water resistance. It is said to remain permanently flexible at below freezing temperatures and is unaffected by temperatures up to 300°F. The product is available in 55 gallon drums and in one and five gallon containers.

Urea Plant Planned

Escambia Chemical Corp., Pensacola, Fla., will start production of urea solutions January 1, 1962 at a new plant, located in Pace, Fla. The plant will have an annual capacity of 20,000 tons. The plant's entire output will be used in Escambia's own Bay-Sol ammoniating solutions and Ammo-Nite, direct application solution.

FDA Clears Dow Latices

Two butadiene-styrene latices of the Dow Chemical Co., Midland, Mich., have been approved for long-term use in food contact application, under a regulation issued by the Food and Drug Administration. The regulation, published in the September 16 *Federal Register*, covers ingredients in both Dow Latex 630 and X-3352. The two latices are used as binders in pigmented paper and paperboard coatings for food contact packaging. Prior to the issuance of the FDA regulation, converters and packagers could rely only on the time extension clause in the 1958 Food Additives Amendment. Officials of the company have expressed the belief that the two products are the first commercial butadiene-styrene latices to have all of their ingredients subject to such coverage completely covered under the Food Additives Amendment of 1958.

KER Resins Introduced

A new series of polyepoxide resins, designated KER Resins, is being produced in commercial quantities by the Koppers Co., Inc., Pittsburgh, Penna. A major advantage of KER resins over diepoxides, according to the manufacturer, is the availability of more than two reactive groups, permitting resin formulators and users to vary the properties of end products to a greater degree than was previously possible. KER polyepoxide resins are derived from an ortho-cresol-formaldehyde novolak which is then reacted with epichlorohydrin to form a polyepoxide. The highly cross-linked structure of the resin is said to result in improved thermal properties and high resistance of solvents and chemicals. In addition, KER resins cure in less time to stable, inert products. Major market uses for epoxies are adhesives, coatings, tooling, encapsulation and potting, laminates and vinyl stabilizers.

• Precision Equipment Co., 4411E N. Ravenswood Ave., Chicago 40, Ill., has issued a wall chart on conversion factors, designed to eliminate difficulty in locating many different conversions.

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Polyurethane Coatings

A new line of polyurethane coatings which offers protection and application ease for molded and extruded rubber parts has been introduced by Hughson Chemical Co., Erie, Penna. Designated as Chemglaze Coatings, the products are polyurethane coatings available as ready-to-use, one-part systems. They are reported to form a protective armor over all common elastomers which defies dirt, abrasion, impact, corrosion, and wear. Exceptional adhesion and high resistance to ozone, grease, oil chemicals, water and other solvents make them particularly attractive for industrial components. The products are suitable for applications over rubber, soft plastics and similar materials. Other Chemglaze Coatings are available in hard versions for use over such substrates as rigid plastics, glass, wood, metal and concrete. Suggested applications that could benefit from Chemglaze Coatings include: conveyor belts and V-belts, hose and hose connections, mounts, gaskets, diaphragms, automobile window channels, toys, and household products.

Vulcan To Build Plant

Construction of a new plant, designed to meet the changing needs in steel packaging, materials, design and delivery has been started by Vulcan-Associated Containers Companies, Inc. The new plant will be located in the Vulcan Industrial Park, Bellwood, Ill. The plant, being built for Vulcan-Bellwood, will employ compact, high production lines for steel pails, small drums and tin cans. Vern I. McCarthy, Jr. is president of Vulcan-Bellwood, and Robert B. Newman is vice-president and director of sales.

• A 12-page illustrated booklet entitled "Wanted! Adhesive Problems", which describes the solution to many difficult adhesive problems and lists new adhesives, coatings and chemical compounds for various industrial applications, is available from Adhesive Products Corp., New York, N.Y.

Alfred J. George

Named Representative

Alfred J. George has been named technical sales representative for the Industrial Adhesives Division of Hadley Bros.-Uhl Co., St. Louis, Mo. He will cover the northern Illinois, Indiana and Michigan territories. Mr. George was formerly associated with B & B Chemical and the Flintkote Co.

Glidden Acquires Pemco

A merger of the Pemco Corp., Baltimore, Md., into the Glidden Co., Baltimore, Md., has been approved by the board of directors of both companies. The merger proposal, however, is subject to approval of stockholders of the two firms. Under the proposed merger agreement, Glidden will exchange 200,000 shares of new 4¼ per cent convertible preferred stock for the 100,000 outstanding Pemco common shares. The new Glidden preferred will be convertible at any time into a total of 225,000 shares of Glidden common at an approximate conversion price of $45 a share. Glidden plans to operate Pemco as a separate unit of its chemicals group. Pemco produces porcelain enamel and ceramic frits, and inorganic colors, used mainly for coating on glass, pottery and signs.

• Troy Chemical Co., Newark, N.J. has developed an antifoaming agent that contains no silicones, does not separate, and is almost water-white. The new product, called Ex-Foam 333, took over five years to develop, the company states.

Armour Fills Sales Posts

Armour Industrial Chemical Co., Chicago, Ill., has made two appointments to its sales staff. R. H. Warner has been named Western regional sales supervisor, with headquarters in Los Angeles, Calif., and E. L. Rhoads has been named Eastern regional sales manager, located in Lodi, N.J.

Mr. Warner graduated from Northwestern University in 1949 with a B.S. degree in chemistry. Prior to joining Armour in 1954 as a special assistant for industrial oils, he worked with A. O. Bauman Co. as a statistician, and Diversey Corp. as a technical service engineer. Mr. Rhoads received his B.S. degree in chemistry from Earlham College in 1947. After working at Devoe and Raynolds as a development chemist, he joined Armour in 1951 in a sales capacity. He became Western sales manager in 1960.

AMP Expanding

American Maize-Products Co., Hammond, Ind., has begun installation of special starch facilities to provide larger quantities of specially treated corn starch products. The project, which is costing $500,000, is scheduled for completion in mid-1962. The special starch unit will bring to $6 million current plant, warehouse and other capital improvement projects at the Hammond facility. Now under construction and scheduled for completion next spring is a $1.5 million warehouse and mechanized packing and shipping unit.

Enjay Plans Expansion

A plan to expand its line of solvents and chemical intermediates has been announced by Enjay Chemical Co., New York, N.Y. New production facilities will be added at the Rahway, N.J. refinery. The principal product that will be made at the new plant is methyl isobutyl ketone (MIBK) which is used in the manufacture of adhesives, lacquers, and organic coatings. The new plant is expected to be completed by the middle of 1962.

Wisconsin Planning Adhesives Symposium

The Third Engineering Institute on Industrial Adhesives Applications will be held on January 16 to 17, 1962, at the University of Wisconsin, Madison, Wisc. The program for the two-day meeting will include papers covering seven topics of interest, and four concurrent group discussions.

The topics to be covered will be: Basic Principles of Adhesive Bonding; Some Important Applications of Adhesives; Design of Joints for Adhesive Bonding;; Equipment Requirements for Adhesive Bonding; Evaluation Techniques for Adhesives; Principles of Adhesive Formulation; and What is the Future of Adhesives.

The subjects of the group discussions will be: Glued Wood Products; Adhesives in Building Construction; Structural Adhesives for Metals and Plastics; and Packaging. The program also includes a dinner meeting, at which a talk will be given by M. E. Lerner, publisher of ADHESIVES AGE, on "What the Adhesives Industry Needs Rather than What It Can Contribute."

The fee for the two-day meeting will be $25. Additional information and applications for attendance can be obtained from William W. Wuerger, Institute Coordinator, Engineering Department Extension Division, University of Wisconsin, Madison 6, Wisc.

Repair Tape Marketed

Mystik Clear Plastic Tape, a product of Mystik Adhesives Products, Inc., Chicago, Ill., is reported to be the strongest man-made film yet to come from the laboratories. The tape is waterproof and can be used for the repair of rainwear, shower curtains, beach toys and auto seat covers. Other uses include mending books, record albums, and sealing packages for mailing, storage, and for articles to be put into a freezer. It is also useful for mounting pictures, signs and posters. The new tape does not discolor, can be easily removed, and will not turn brittle or crack. The tape is available in widths of ¾ and 1½ inches and is packaged in individual dispensers.

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Pseudocumene Available

Enjay Chemical Co., New York, N.Y., is offering pseudocumene in commercial bulk quantities. Previously available as a market development chemical, pseudocumene (1, 2, 4-trimethylbenzene is suggested for a number of new end-use applications, including trimellitic anhydride, methyl dicarboxylic acids and dimethylcarboxylic acids — all of which have potential in the surface coatings fields. It is also suitable for conversion to intermediates suitable for dyes, pharmaceuticals, insecticides, fungicides and other interesting chemical intermediates. Commercial specifications for pseudocumene include a 95 per cent minimum purity with a 98 per cent minimum total aromatic content. Typical inspections are: boiling range 335° to 340° F. water-white color, flash of 123° F.

Extrusion Coating Resins

Seven polyethylene resins designed for extrusion coating and lamination of paper, paperboard, foils, films and fabrics have been introduced by Dow Chemical Co., Midland, Mich. Designated CG, for coating grade, the resins vary in melt index and density to contribute specific properties needed in different packaging, construction, and textile applications. The coating grade resins are said to be precisely engineered to carry PE properties to flexible webs by meeting commercial processing and equipment requirements. The Dow polyethylene coating grade resins are CG 1902, CG 1705, CG 1705-B, CG 1608, CG 2502, CG 2504, and CG 3002. The first two numbers indicate density; the last digit approximates melt index; and alphabet suffixes denote compounding variables.

• Shawinigan Resins Corp., Springfield, Mass., has appointed the Breffeilh Co., New Orleans, La., as its sales representative in Mississippi, Alabama and metropolitan New Orleans and Pensacola, Fla. The Breffeilh organization will handle Shawinigan's entire line of polyvinyl resins and emulsions.

OBITUARIES

Edward L. Pezolt

Edward L. Pezolt, vice-president of the Bradley & Vrooman Co., Chicago, Ill., died on July 21 at Passavant Memorial Hospital, Chicago. A graduate of Northwestern University, Mr. Pezolt entered the advertising field before joining Bradley & Vrooman in 1913 in the Advertising Department. He was appointed advertising and sales manager in 1926, and two years later was promoted to vice-president. His long association with the firm was interrupted briefly by World War 1 when he served as a flying instructor. He rejoined the company in 1920. Mr. Pezolt leaves his widow and three step-children.

John Holmes

John Holmes, former president and chairman of Swift & Co., Chicago, Ill., died October 21 in Tucson, Ariz. He was 71 years old. Mr. Holmes, a native of Belfast, Ireland, joined the Swift firm as a messenger boy when he was 15 years old. He was president of the company from 1937 to 1955 when he retired and became chairman. He relinquished the chairmanship in 1959 and resigned as a director in January of this year. Surviving are his widow and two daughters.

Plant Site Selected

National Starch and Chemical Corp., New York, N. Y., has revealed that land has been purchased at Seadrift, Texas for the building of a $4 million vinyl acetate plant with an annual capacity of 45 million pounds. Construction of the new plant will commence later this year, and will be in operation in late 1962. National Starch will purchase its acetylene, a major raw material used in the production of vinyl acetate, from the Olefins Co., a division of Union Carbide Corp., New York, N. Y.

Offers Epoxy Diluent

Antara Chemicals Division of the General Aniline & Film Corp., New York, N.Y., has announced the commercial availability of Agent AT-534, a non-toxic, low cost epoxy reactive diluent which is said to effectively reduce the viscosity of liquid epoxy systems. The high-boiling, odorless liquid reacts readily with epoxy curing admixtures without any appreciable affect on the rate of cure of gel, even at room temperature. Agent AT-534 permits long storage under normal conditions. The company estimates that by 1963 the sale of epoxy resins will reach 90 million pounds annually. It is expected that 70 per cent of this total will be liquid-type systems.

Heat Reactive Resin

Piccodiene 2215, a heat reactive resin has been added to the product lineup of Pennsylvania Industrial Chemical Corp., Clairton, Penna. The resin is a highly aromatic polymer with unsaturable double bonds which finds use in the preparation of adhesives. Piccodiene 2215 is also furnished in a special rubber grade, which is stable to oxidation and high temperatures. In rubber compounding, this product improves processing, raises heat resistance, and promotes the retention of high tensile strength and resistance to abrasion. It is also available as a solid resin, flaked with multiwall bags, or as a solution in mineral spirits.

Producing Polyamide

Cemco, Inc., New York, N.Y. is producing a new line of polyamide and amino resins to be used for adhesives, inks and protective coatings. The firm is producing thermoplastic polyamide resins and thermosetting polyamide resins. In addition, the firm is producing Cem-Cure, a series of amino resinous products, which are reported to be effective, low-cost epoxy curing agents. The Cem-Cure resins range from semi-solids to low viscosities and are expected to find new applications in the coatings and construction industries.

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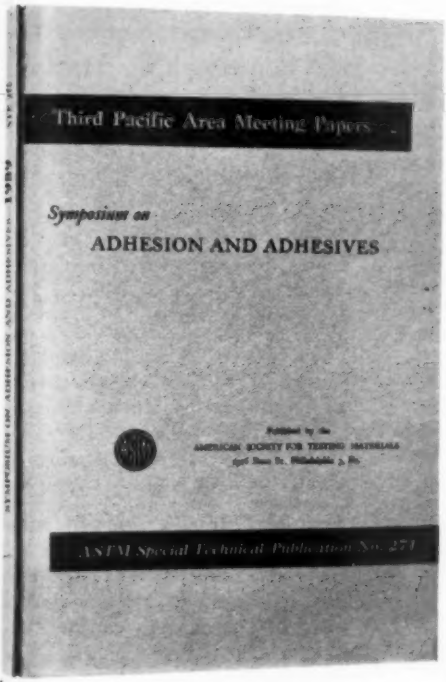

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6 x 9 In. 66+ Pages Hard Cover

This volume makes available in printed form material originally presented at the Third Pacific Area Meeting held by the American Society for Testing Materials at San Francisco in October, 1959. It also incorporates data and statistical analysis of a study undertaken to determine the effects of increases in the rate of loading on the strength properties of adhesives.

Although the volume is neither a complete nor an extensive study of the manifold problems relating to adhesives, it does answer some of the many questions of those engineers who have not used adhesives for metal applications and who, with additional encouragement, may incorporate adhesives in their designs.

The volume is a powerful impetus to the use, the technology, and the testing of all adhesives. Metal-to-metal adhesives, relative newcomers to the rapidly growing field of industrial adhesives, have grown in importance to such an extent that no designer can justify overlooking their advantages.

TABLE OF CONTENTS:

Lap Shear and Creep Testing of Metal-to-Metal Adhesive Bonds in Germany —By K. F. Hahn, Douglas Aircraft Co.

Elevated Temperature Resistant Metal-to-Metal Adhesives Derived from Organic-Inorganic Polymer Systems—By E. C. Janis, Narmco Industries, Inc.

Preliminary Evaluation of Ceramic Adhesives for Stainless Steel—By L. E. Gates and W. E. Lent, Hughes Aircraft Co.

Tensile Shear Strength of Adhesive Bonded Metals as a Function of the Rate of Loading—By D. A. George, John Mandel, National Bureau of Standards, and H. R. Butzlaff, A. O. Smith Corp.

Bonded Metal-to-Metal Shear Testing—By L. R. Lunsford, Convair Division, General Dynamics Corp.

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names in the news

Reed Stuart Hammond, senior operating vice-president, and general manager of the Building Products Division of the Johns-Manville Corp., New York, N.Y., has retired.

William C. Mackie, formerly West Coast district manager, has been appointed Midwest district sales manager for Rhodia, Inc., New York, N.Y. *Everett J. Weaver,* previously in charge of the southern territory, has been named assistant to Mr. Mackie.

Anthony J. Testa has joined the Dewey & Almy Chemical Division of W. R. Grace & Co., Cambridge, Mass., as a chemist in the Container and Chemical Specialties Divison.

Theodore R. Hopper has joined the applications group of the Epoxy Department of the FMC Corp., Princeton, N.J., where he will work on Oxiron resins.

Stephen Basarab has been named plant manager of the de-tinning plant of the Metal & Thermit Corp., Carteret, N.J.

Hugh C. Marx has been named organization planning manager for the Olin Mathieson Chemical Corp., New York, N.Y.

John P. Birtwell has been named by Crocker, Burbank Papers Inc., Fitchburg, Mass., as regional manager of sales of industrial and converting papers in the Chicago, Ill. area.

B. Ross Nason, formerly director of manufacturing for the Inorganic Chemicals Division of the Monsanto Chemical Co., has been named director of manufacturing and engineering for the Mobay Chemical Co., Pittsburgh, Penna.

Kenneth A. Rayburn, formerly of the University of Idaho, has been named research chemist at the Chemical Research and Development Center of FMC Corp., Princeton, N. J.

G. L. Werly, Jr. has been appointed general marketing manager of the Air Reduction Sales Co., New York, New York.

Richard S. Abrams, formerly general manager of the Silicones Division of the Union Carbide Corp., New York, N.Y., has been appointed manager of development for the Union Carbide Olefins Co., a division of Union Carbide Corp. *James C. Malone,* formerly assistant to the general manager of the Silicones Division, succeeds Mr. Abrams as general manager.

Dr. Ezra Khedouri has joined Shawinigan Resins Corp., Springfield, Mass., as a research chemist.

Donald H. Hogle has left Westinghouse to join the central research laboratories of Minnesota Mining & Manufacturing Co., St. Paul, Minn., as senior research chemist.

Wlodek L. Ginilewicz has been named technical service supervisor of Air Reduction Chemical & Carbide Co, New York, N. Y.

Dr. William F. Beach and *Dr. Louis A. Pilato* have joined the Research Department of Union Carbide Plastics Co., Bound Brook, N. J.

John S. Atwood has been promoted to assistant vice-president of the Plastics Division of the Koppers Co., Pittsburgh, Penna.

Harold B. Kirkpatrick, formerly manager of the Brooklyn, N.Y. plant of Reichhold Chemicals, Inc., White Plains, N.Y., has been appointed to the newly created position of manager, market development melamine resins, in the Plastics Division.

Eger V. Murphree, president of Esso Research & Engineering Co., New York, N. Y. will head the U. S. team that is to participate in the Sixth World Petroleum Congress to be held in Frankfurt, Germany in June, 1963.

Dr. Stuart B. Monroe, formerly of the University of Florida, has joined Hercules Powder Co., Research Center, Wilmington, De., as research chemist.

Dr. Henri C. Silberman, formerly of A. E. Staley Mfg. Co., has been named a research scientist at the Philip Morris Research Center, Richmond, Va.

Leonard V. Cerwin, director of technical services, Mystik Adhesives Products Co., Chicago, Ill., has been elected to the Steering Committee of the Technical Group of the Pressure Sensitive Tape Council.

Kurt J. Wasserman, who heads the Wasco Laboratories, has been retained as a consultant by Commercial Solvents Corp., New York, N. Y.

William J. Houston has been promoted to executive vice-president of Nuodex Products Division of Heyden Newport Chemical Corp., New York, N. Y.

Joseph R. Dill, has been named vice-president for administration by the Borden Chemical Co., New York, N. Y. He will continue as the firm's controller.

Stan L. Ostrenga, national industrial sales manager of Mystik Adhesives Products, Inc., has been elected chairman of the Simplified Practices Committee of the Pressure Sensitive Tape Council, Chicago, Ill.

Karl M. Birman has been named marketing staff manager of the Armour Industrial Chemical Co., Chicago, Ill.

Edward T. Kubu has been appointed assistant director of laboratory research at the central research laboratory of Allied Chemical Co., Morris Township, N. J.

William E. Houghton has been appointed manager of market surveys of the General Chemical Division of Allied Chemical Corp., New York, N. Y.

Dr. Donald L. Heywood has been appointed group leader in research and development at Union Carbide Chemicals Co., South Charleston, West Va.

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Armour Enters Tape Field

Armour Alliance Industries, a division of Armour & Co., Alliance, Ohio, has introduced a complete line of pressure-sensitive tapes for both home use and industry, marking the company's first entry into the field. Various tapes for masking, sealing, holding, protecting, reinforcing, splicing, identifying and packaging applications are now available. Types of pressure-sensitive tape being offered include standard and high temperature masking tapes, protective tape, cloth tapes, electrical tape, freezer tape, strapping tapes, double-faced adhesive polyethylene tape, etc. The tapes will be marketed by the Armour Coated Abrasives Division through the company's industrial distributors and retail jobbers.

Glidden Expands Capacity

Glidden Co. will spend more than $1 million in an expansion of its coatings and resin plants in Atlanta, Ga., Chicago, Ill, St. Louis, Mo., and Toronto, Ont., Canada. The expansion calls for increased floor space and new production equipment which will increase capacity by as much as 25 per cent at the four facilities.

A-M Earnings Improve

Earnings of the American-Marietta Corp. for the first nine months ended August 31 dropped to $15,462,450, the equivalent of $1.11 a share, from $17,202,260 or $1.26 a share, for the comparable period ended 1960. Earnings for the third quarter ended August 31 showed marked improvement, however, and the company reported record profits of $9,151,596, equal to 67¢ a share, compared with $8,240,524, or 60¢ a share, for the same quarter a year ago. Sales for the first three quarters of the current fiscal year rose to $268,483,257 from $268,069,005 last year, while sales in the third quarter totaled $111,253,023, compared with $107,153,406 in the 1960 period.

Melamine Unit On Stream

American Cyanamid Co., New York, N.Y., has gone into production at its new melamine plant at Gosport, England. The 3,000 ton-per-year unit, operated by Cyanamid of Great Britain, Ltd., is reported to have cost $500,000. Its melamine crystal output will be used in the manufacture of resins, laminates, and molding powders.

3M to Sell Zenith

Minnesota Mining & Mfg. C., St. Paul, Minn., and H. I. Thompson Fiber Glass Co., Los Angeles, Calif., have reached a preliminary agreement for the sale of the facilities of 3M's Zenith Plastics Division Gardena, Calif., to H. I. Thompson. While basic principles have been approved by the board of directors of each of the two firms, however, no contract has been signed. Details of the proposed transaction were not disclosed. A spokesman for Minnesota Mining stated that the sale of the Gardena facility was being made primarily to avoid competition with customers of 3M's Reinforced Plastics Division.

LePage's Offers Thriftape

A 1500-inch roll of ½-inch household and office cellophane tape has been introduced by LePage's, New York, N.Y. The transparent tape, called Thriftape, is being marketed at 39¢ a roll, and is said to represent the same value as seven 25¢ rolls of the same product in competitive lines. The company states that the quality of the tape is the same, or better. The new roll is packaged in an easy-to-use cellophane tape plastic dispenser.

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ADHESIVES GUIDE

by JOYCE HURD

• A Practical Handbook

designed to serve as a guide to the types of adhesives available for bonding various materials in various applications. This new British publication covers adhesives used in woodworking, bookbinding, footwear, etc., and offers valuable data on the advantages of adhesive bonding and the classification of adhesives.

Topics Covered

Choice of Adhesives for Various Materials.

Encyclopedia of Basic Adhesive Types.

Classification of Manufacturers (British) by Basic Types of Adhesives Made

Catalog of Adhesive Manufacturers and Their Products

Trade Name Index (British)

Miscellaneous Adhesive Recipes

British Organizations Concerned With Adhesives

Bibliography

With contents including data on something like 400 individual adhesives made by about 100 different manufacturers, this publication will prove to be a valuable edition to your technical library. More than 50 main types of adhesives and their properties are covered.

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Dec. 4-6. Chemical Specialties Manufacturers Association, 48th Annual Meeting, Roosevelt Hotel, New York, N.Y.

Dec. 7. Synthetic Organic Chemical Manufacturers Association, Annual Meeting, Roosevelt Hotel, New York, N.Y.

Dec. 7-8. Society of the Plastics Industry, 9th Plastic Film, Sheeting & Coated Fabrics Conference, Pierre Hotel, New York, N.Y.

Dec. 26-31. American Association for the Advancement of Science, Chemistry Division Annual Meeting, Denver, Colo.

Jan. 16-17, 1962. Engineering Institute on Industrial Adhesives Applications, University of Wisconsin, Madison, Wisc.

Jan. 25, 1962. National Fibre Can & Tube Association, Biltmore Hotel, New York, N.Y.

Jan. 30-Feb. 2, 1962. Society of Plastics Engineers, 18th Annual Technical Conference, Penn-Sheraton Hotel, Pittsburgh, Penna.

Feb. 5-9, 1962. ASTM Committee Week, Statler Hilton Hotel, Dallas, Texas.

Feb. 6-8, 1962. Society of the Plastics Industry, 17th Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Ill.

Feb. 18-22, 1962. TAPPI, 47th Annual Meeting, Commodore Hotel, New York, N.Y.

Mar. 6-8, 1962. Material Handling Institute, Pacific Coast Show, Pan Pacific Auditorium, Los Angeles, Calif.

Mar. 13-14, 1962. Manufacturing Chemists' Association, Symposium on Packaging of Chemical Products, Chase-Park Plaza Hotels, St. Louis, Mo.

Mar. 14-18, 1962. National Flexible Packaging Association, Spring Meeting, Boca Raton, Fla.

Mar. 20-29, 1962. American Chemical Society, 141st National Meeting, Washington, D.C.

Mar. 22-23, 1962. ASTM, Committee D-14 on Adhesives, Hotel Sheraton-Atlantic, New York, N.Y.

Apr. 2-7, 1962. Society of the Plastics Industry, Western Section Annual Conference, Hotel del Coronado, Coronado, Calif.

Apr. 9-12, 1962. American Management Association, 31st National Packaging Show & Conference, New York Coliseum and Hotel Roosevelt, New York, N.Y.

Apr. 25-29, 1962. Western Space Age Industries and Engineering Exposition, Cow Palace, San Francisco, Calif.

Apr. 29-May 3, 1962. American Ceramic Society, 64th Annual Meeting, New York, N.Y.

May 9-11, 1962. Western Material Handling and Packaging Show, Great Western Exhibit Center, Los Angeles, Calif.

May 13-15, 1962. National Fibre Can & Tube Association, 29th Annual Meeting, Grand Hotel, Point Clear, Ala.

May 14-16, 1962. TAPPI, 13th Coating Conference, Netherland-Hilton Hotel, Cincinnati, Ohio.

Portrait of

ROBERT S. FORSYTH

Robert S. Forsyth is chief chemist of the research and development laboratories of National Starch and Chemical Company's National Adhesives division. Because of his broad background in most aspects of the packaging adhesive field, Mr. Forsyth has been assigned responsibility for the company's laboratory development and technical services. Though he operates out of National's laboratories in Plainfield, N.J., much of his work takes him out into the field to examine and analyze new developments.

Mr. Forsyth, who has been with National for nine years, received his bachelor of science degree in chemical engineering from Lafayette College, Easton, Penna., in 1952. He received a master of science degree from Stevens Institute of Technology, Hoboken, N.J., in 1959, and has also done work in polymer chemistry at Brooklyn Polytechnical Institute.

A featured speaker at the recent National Packaging Forum held in New York, Mr. Forsyth will soon be represented in *Adhesives Age* by an article on "New Developments in Synthetic Resin Hot Melt Adhesives."

FDA Clears Additives

Final regulations have been published by the Food and Drug Administration clearing paper defoamers and adhesive additives, produced by Nopco Chemical Co., Newark, N.J., for use in the manufacture of paper, paperboard and containers for the packaging, transporting and holding of food. The list of products cleared on August 30, 1961, includes 116 pulp and paper defoamers. Other miscellaneous products, wax and wax/resin sizes, dispersing and wetting agents are included in extensions granted by the FDA until January 1, 1962. On September 12, 1961, the FDA cleared 42 Nopco defoamers, stabilizers, thickeners and resin emulsions; and 22 miscellaneous products, wetting and dispersing agents, stearate dispersions, as additives for adhesives used in food packaging. Five other adhesive component products received extensions until July 1, 1962.

Bemis To Buy Film Firm

Bemis Bro. Bag Co., Boston, Mass., has entered into an agreement to acquire the assets and business of Plastic Film Co., Plainfield, Conn., as of January 2, 1962. Plastic Film specializes in the coating and laminating of a wide variety of materials, including paper, plastics, foil and films. Plastic Film had sales of $12,500,000 for the fiscal year ended September 30, 1961, and it is estimated that sales for the 1962 period will reach $15 million. Plastic Film will be operated as a wholly owned subsidiary of Bemis. Its present management will continue with William B. Nichols, as chairman of the board, A. C. Bruce as president, and E. V. Disch as vice-president and general manager.

Allied Expands

Allied Adhesive Corp., Brooklyn, N.Y. has acquired additional space in two buildings adjoining its present plant. In addition to more than doubling the manufacturing space, a portion of the space has been allocated for research and development of packaging and laminating adhesives.

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Adhesive Council Sets Long Range Programs

Since its founding, the activities of the Rubber & Plastic Adhesive & Sealant Manufacturer's Council have been to serve the industry and to promote its products. It is through its nine committees that the major effort of the Adhesives Council toward reaching its goal—defined by the Council's founders as the "promotion, advancement, and encouragement of the use of rubber and plastic adhesives and sealants"—is carried forward.

Nine Standing Committees

The nine Adhesive Council committees are: Steering, Technical, Public Relations, Product Liability and Labeling, Traffic, Statistics and Survey, Marketing, Rules and Ethics, and Program.

At the outset there was a single committee, the Steering Committee, which, in effect, operates the Council and answers to its board of directors. The board, upon recommendation from the Steering Committee, creates new committees as new programs are initiated or different problems arise.

Technical Committee Scope

The Technical Committee, first to be established, operates with five subcommittees, each with its own problems, procedures and objectives. These five are: Dry Wall Adhesives, Hallmark, Contact Bond Adhesive, Ceramic Tile, and Curtain Wall Sealant.

The Ceramic Tile Subcommittee has two long range programs underway. The first of these is a Round Robin testing program. This program offers all members of the Adhesive Council, involved with the manufacture and use of adhesives for setting ceramic tile, an opportunity to have their adhesives tested by an independent laboratory.

Also in the general field of industrial construction, the Technical Committee has assigned the Curtain Wall Subcommittee to look into the many problems that surround the installation of contemporary curtain wall panels in both office and industrial buildings. The range of the subcommittee's studies will extend from older types of rubber sealant and locking devices to plastics that are liquid when applied and which set into a flexible seal after placement and exposure.

The Contact Bond Adhesives Subcommittee, which was recently organized, will have as its broad purpose the development of a specification for contact bond cement and will study the possibility of gathering data relative to applications and methods of meeting difficulties in high pressure laminating operations.

Hallmark Program

One of the long range programs adopted by the Council is the establishment of a Hallmark. The objective of this program, being developed by the Hallmark Subcommittee, is to give the general public and users of rubber and plastic adhesives and sealants a mark of assured quality to guide them in the buying and use of adhesives.

The emphasis of the Technical Committee on the construction industry is easily explained by the results of a survey made by the Council's Public Relations Committee. This committee is basically responsible for helping Adhesive Council members to work collectively in informing the users of rubber and plastic adhesives and sealants about the industry as well as helping the industry to put its best foot forward.

"What's the meaning of this, Dudley? I ask you to give me a complete analysis on the physical possibilities of adhesives in outer space, and the minute my back is turned, you're in here playing with 'tinker toys'!"

Industry Image Important

While the Public Relations Committee works toward improving the image of the industry and its products, the Product Liability and Labeling Committee is helping members to avoid situations which might impair the image of the industry as well as the individual members. This committee has provided a continuous stream of information related to alleged misrepresentations, legal implications of labeling practices with emphasis on health and safety hazards, state laws, municipal fire department regulations, and other limitations on the labeling of adhesives.

Labeling and liability are sometimes problems in the shipping of adhesives and sealants. This is handled by the Traffic Committee. One of the earliest tasks of the committee was to establish the differentiation between paste, cement, and adhesive. The Traffic Committee's future program revolves around establishing that it does, in fact, represent the adhesives industry, and it is now engaged in determining the quantities of adhesives shipped. With the additional facts in hand, the Traffic Committee believes that much duplication now in existence in terms of Interstate Commerce Commission and carrier regulations may be reduced or eliminated.

Gathering Statistics

The problem faced by the Traffic Committee in obtaining sufficient statistics on the shipment of adhesives falls to the Statistics and Survey Committee. This committee was organized to study and determine the types of statistical information most useful for Adhesive Council member firms, and to recommend

to the board of directors surveys and reports of value to the industry.

Closely related to the work of the Statistics and Survey Committee is the work of the recently-formed Marketing Committee. This committee will engage in a two-sided approach to marketing problems pertinent to adhesives. First, through the use of statistics and similar data, the Marketing Committee will attempt to pinpoint and give advance notice to members of trends in the industry which indicate the development of potential markets. Second, marketing techniques will be studied and the Council members will receive information about new approaches to the sales and distribution of adhesives and sealants that seem to be working effectively for others.

The most recently formed committee is the Rules and Ethics Committee. It has set itself to the task of developing a code of ethics for Council members. This committee may also become involved in membership requirements and related problems.

The Adhesive Council's work for its members is not carried on entirely through these committees. At the three meetings held each year, outstanding speakers are brought in by the Program Committee to address the Council members on current problems relating to the industry and some segment of the national economy. In addition to speakers, in at least one meeting of the year a two-day seminar is held. Some of these seminars are developed by the Program Committee and others by the national office of the Adhesive Council.

Newsletters and special mailings on a wide variety of subjects emanate from the national office throughout the year. This material keeps the members abreast of the latest incidents in the industry, with emphasis on Adhesive Council and member activities.

• The Spinco Division of Beckman Instruments, Inc., Palo Alto, Calif., is offering a 20-minute, 16-mm. color film which shows how to analyze drop-size samples with the Beckman Ultramicro Analytical System.

Presstite Plant Set

Contracts have been awarded for the construction of a plant in Canada to manufacture essentially the full Presstite line, products of the Presstite Division of American-Marietta Co., Chicago, Illinois. The concrete and brick structure will be erected in Georgetown, Ontario, Canada, and will turn out sealants, insulation and caulking compounds and other industrial chemical products. The plant is scheduled to start production in the spring of 1962. Operating as a subsidiary of the American-Marietta Co., the new plant will be managed and operated by Canadian personnel.

Binder Labels Introduced

Avery Label Co., Monrovia, Calif., has developed a "permanent" label for identifying binders, ledgers, briefcases, luggage, manuscripts and other objects. Called Binder Labels, the self-adhesive labels are said to be easy to write or type on, and to adhere on contact, with simple finger-tip pressure.

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new equipment

Hand Operated Sealant Gun

An all-metal, manually operated sealant gun, designed for use with standard 2½-ounce and 6-ounce polyethylene cartridges, can dispense any of the one and two-part adhesives, compounds, epoxys, polysulfides, and silicones. Known as

the SP 1832 Hand Gun, this lightweight, low cost gun is ideal for use in the field where air pressure is not available. Its sturdy, corrosion-resistant, all-metal construction is said to offer trouble-free service. Employing a comfortable pistol grip with ratchet and lever action, the SP 1832 is well balanced for easy operation. A sturdy, threaded metal collar slides over the polyethylene cartridge and attaches to the gun handle, firmly gripping the cartridge at the base. Clean-up is said to be eliminated, as the polyethylene cartridges are disposable, and at no time does any metal part contact the compound being dispensed. *Pyles Industries, Inc.* **E-380**

Kemlon Pump 150-7

Specifically intended for handling corrosive slurries at pressures up to 3000 psi, the Kemlon Pump, Model 150-7 is a diaphragm type unit. The new pump, utilizing the basic design of the patented Kemlon Pump, has a barrier diaphragm which separates all the working parts from the fluid handled. Where ordinary diaphragm pumps depend on force exerted by the diaphragm itself to do the pumping, the Kemlon Pump employs an actuating fluid between the piston and diaphragm without mechanical linkage of any kind. All surfaces of the pump which contact corrosive media are of Teflon and inert metals. The valves are said to be a proven design featuring a spring loaded guided cone sealing on a hardened edge. Other important features include a cast steel water-cooled housing for high temperature and high pressure service, prelubricated anti-friction bearings, adjustable stroke for variable volume, and positive metering over a wide pressure range. *Keystone Engineering Co.* **E-381**

Liquid Degasser

The On-The-Fly Degasser is designed to degas liquids used in the production of castings free from voids caused by entrapped gases. The manufacturer claims that the unit will rapidly remove dissolved or entrapped gasses and other volatile materials from either a continuous or intermittent flow of liquids by means of vacuum and heat. It will handle a broad range of liquid or hot melt materials such as epoxies, urethanes, polyesters, waxes, vinyl plastisols, and petroleum and coal tars. The unit consists of a heating and rough degassing section with a combination output and recirculation pump. All sections are under vacuum and heated. The output pump, driven by a continuously variable speed air motor, feeds the material out as demanded or recirculates it through the system. *Automatic Process Control, Inc.* **E-382**

FOR MORE INFORMATION on these new products use the Readers' Service Coupon on page 44.

High Speed Labeling Unit

The Model OV, high speed, automatic labeling machine for applying thermoplastic decals to flat and variously shaped surfaces of plastic, rubber, leather and cloth, automatically applies 800 to 1,000 decals per hour. This model is one of six offered by the manufacturer. Capability of this equipment includes application of decals on

rigid, semi-rigid, and flexible polyvinyl chloride tubing. Decals remain clearly visible, permanently fused to the plastic material even after continuous abrasion, stretching and bending of the product in use. Multi-colored labels and decals are made to order by a patented method in a wide variety of shapes, sizes, and designs. *Saxton Barrett Co.* **E-383**

Portable Rotator

Designed to agitate or mix drum contents up to 500 pounds in 30 to 55 gallon drums, the 200 Rotator has been strengthened with two horizontal channel sections to give greater rigidity to the equipment. The idler reduction housing now has slotted brackets for chain adjustment and the shaft size has been increased. A chain guard is now standard equipment on the exposed sprocket for safe operation and a reinforcer has been added to the safety nose piece for greater stability. *Morse Manufacturing Co.* **E-384**

Twin Stick Labeler

A new labeler for moistening double gummed labels, known as the Twin Stick, is said to be ideally suited for use in attaching ungummed address labels and sales slips to packages by means of double gummed labels. According to the company, the Twin Stick labeler offers the following design features: two brushes, immersed in a large capacity reservoir, which provide direct water flow to each side of the label; a polished aluminum cover over the reservoir and brushes, which protects merchandise from becoming soiled; identical brushes which can be reversed for double life. *Carry-Pack Co., Ltd.* **E-385**

Perforating Machine

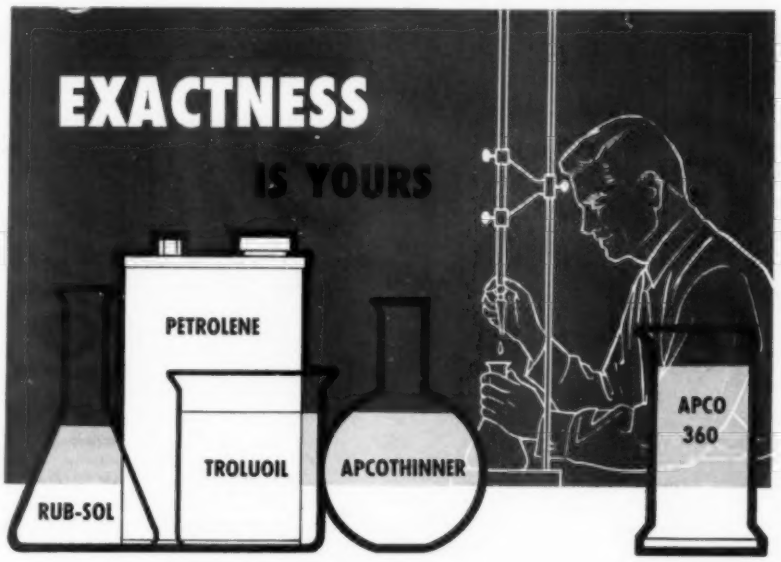
A production perforating machine, the unit will perforate such materials as coated products, rubber, foil, paper, plastic film, cloth, leather, cardboard, etc., where many holes are needed. In addition, film and sheet materials can be made porous, breathable, or easier to laminate or combine, states the manufacturer. The machine is made in roll widths of 38", 48", and 60", with various needle point patterns. Pins in the perforating roll are alloy steel, heat treated for long wear, and are replaceable. A standard model is equipped with a variable speed drive. *Robert A. Main & Sons, Inc.* **E-386**

Automatic Weigher-Bagger

An improved gross weighing bagger for 6, 8, and 10X powdered starch and similar free-flowing materials that tend to aerate, the Series G18R fills 100 pound bags at rates up to 3 bags per minute with an accuracy of $\pm 1/10$ of 1 per cent. Accurate feeding is attained with a vane type feeder that incorporates two shut-off gates for two feed rates. The manufacturer's Flexure-Plate scale which supports a pneumatic expanding type bag holder, contains mercury switches which control the bagging process. The scale weigh beam position actuates the mercury switches which emit impulses to provide controls. *Thayer Scale Corp.* **E-387**

Machine-Mount Glue Guns

Available in roller-widths of one quarter to six inches, machine-mount glue guns, for high speed coating of flat surface areas, measure just two inches front to back. These FF guns (Series R) will lay an accurate ribbon or multiple bead pattern of adhesive at any sealing speed, the manufacturer reports. The guns incorporate a ball-spring plunger valve control which can be actuated by a solenoid valve, electric eye arrangement, or other mechanical means. Other additions to the line include a selection of gun bodies (Type C) featuring an internal valve action identical to that employed in the Series R guns. Type C bodies measure $1\frac{1}{2}$ x $1\frac{1}{2}$ x $1\frac{1}{2}$ inches and can be fitted with FF gun tips to perform a wide variety of operations, such as roller, groove and angle gluing. All-metal construction makes these units ideally suited for applying highly corrosive adhesives. The guns can be used manually if desired. *John P. Fox Co.* **E-388**



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In rubber cement and other adhesives where fast but uniform drying is needed to eliminate pinholing and blistering, PETROLENE is the answer. High solvency combined with controlled evaporation are yours in APCO-THINNER.

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book reviews

Progress in Dielectrics, Vol. I. ***Edited by J. B. Birks; American Editor, J. H. Schulman. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 6 x 9¾ in. 312 pp. $11.00***

This is the first volume in a planned series on dielectrics. The series is being published on a one-volume-a-year basis on the premise that there is a need for a common meeting ground for scientists, engineers, and technicians working on dielectric problems within the various disciplines or industries, and that they can benefit from papers which transcend a given field or have implications for more than one.

With this orientation the editors have attempted to coordinate current knowledge of dielectric phenomena, materials, and techniques, and to give a review of recent progress in different aspects of the subject. The search has taken them from physics to biology, electronics, high polymers and as far afield as radiation chemistry.

The seven papers which comprise this initial volume are equally eclectric:

(1) Dielectric Breakdown in Solid Insulation, by J. H. Mason.
(2) Directional Break-down Effects in Crystals. By J. W. Davisson.
(3) Electric Strength and High-Field Conductivity of Dielectric Liquids. By T. J. Lewis.
(4) Gaseous Dielectrics. By T. W. Liao and R. E. Plump.
(5) Ferroelectricity of Barium Titanate Single Crystals. By A. D. Franklin.
(6) Non-oxide Ceramic Dielectrics. By P. Popper
(7) Electrophoretic Deposition of Insulating Materials. By J. B. Birks.

The first four papers in this book discuss dielectric breakdown with emphasis on solid, liquid, and gaseous dielectrics. The paper by Franklin is described by the editor as a presentation of "the substantial progress that has been made towards a unified thermodynamic theory." The paper by Popper is a review of the elements and binary compounds as potential ceramic dielectrics with attention focused on the nonmetallic nitrides. The final article describes the theory and practice of electrophoretic deposition of insulation.

In brief it would seem that this first volume achieves its stated goal. While the papers themselves are academic in approach, the commercial implications of the various topics are dealt with to an extent where further research on a given problem can be pursued with reasonably facility.

Charts, illustrations, and literature references are supplied. This volume may be of use to the reader occupied with problems of electrical insulation in the rubber industry. It would certainly be a valuable addition to a good technical library on the subject.

Scandinavian Research Guide. ***Published by Scandinavian Council for Applied Research, Gaustadalleen 30, Blindern, Norway. In two volumes. 6 x 9 in. Approximately 700 pages in each. Softbound $10.00.***

This Guide is a remarkable collection of information, unique in its comprehensive coverage of who is doing what, where, in science and technology in the five Scandinavian countries: Denmark, Finland, Iceland, Norway, and Sweden. More unusual is the fact that the Guide is directed to the outside world. The decision to publish it in English, as opposed to one of the Scandinavian languages, was made with this in mind.

The aim of the two-volume set is, in the words of the secretary-general of SCAR, to further cooperation between institutions and persons engaged in scientific and technical research. It is also intended as a source of information for industrial firms, and trade organizations interested in making research contacts.

The compilation of over 1,500 research organizations within science and technology (but excluding life sciences) gives practically complete information about each institution: the name, address, telephone number, the head or officiating officer, the size of the group, a brief summary of its activities, policies concerning contracts for research, and its publications, if any.

A superb classification system makes it simple to find the names of institutions or persons involved in a specific field.

The set is divided into seven sections. Volume I contains a complete list of research institutes and laboratories arranged by Universal Decimal System into categories. Rubber, for instance, is listed under High Polymers, including plastics and rubber; two research institutes are listed. One, a small plastics laboratory with three scientists, is working in the fields of reinforced plastics, shrinkage in injection molding of plastics, and techniques for injection molding of polyamides (nylon). A second laboratory, with 15 workers, is specializing in sponsored research for the organic chemical industry, and for the plastics, rubber, paint, and adhesive industries. The last mentioned work involves chemical and physical investigations of high polymer materials, fillers and other additives, materials testing, and development of forming and finishing operations.

The remaining six sections, in Volume II, group together in the same fashion Central Research Organizations, Universities and Institutes of Technology, Scientific Societies and Their Publications, Central Scientific and Technical Libraries and Information Services, Productivity Centers, and a Bibliography.

As can be seen from the above, the Guide is superbly organized and cross-indexed, and a model of convenience as a tool.

Trade Literature

BONDING REINFORCED TEFLON. This three-page bulletin describes how reinforced Teflon, after etching, may be bonded to itself with many commercial adhesives. The bulletin lists systems, conditions and remarks on 10 commercial adhesives, telling given situations in each case. The text also describes adhesives for bonding Reinforced Teflon to metals. It states that sodium etched Reinforced Teflon has been bonded to metals successfully and cites case examples where the adhesive has been applied to various metals. The bulletin further states that bonding can be done without etching if the adhesive used is Teflon FEP film. Pressures from 200-800 psi and temperatures in the 640-680° F. range are generally satisfactory. *Rogers Corp.* **L-434**

SLIP PROOF FABRIC. This four-page brochure describes Slip Proof, a new product that prevents slips and falls and provides greater traction and safety. The pamphlet states that the fabric comes in handy cleats or strips for stairways, ladders, and fire escapes. The material is also available in rolls up to 24-inches wide by 96-inches long, for tailoring to practically any safety tread problem in homes and factories. *Carborundum Co.* **L-435**

PRESSURE-SENSITIVE TAPES. Titled "Mystik Tapes Keep Costs Down!", this 44-page guide gives handy reference data on the manufacturer's full line of paper masking tapes, packaging tapes, protective coverings, high-low temperature tapes, electrical tapes, printable tapes, and specialties. Typical tape applications are suggested, and a quick reference index speeds up the selection of tapes. *Mystik Adhesive Products, Inc.* **L-436**

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Subscribers to ADHESIVES AGE may now obtain, from one central source, technical literature dealing with all aspects of the adhesives industry. One or more of the books listed here may be of invaluable assistance to you. Look this list over and check the books suited to your needs.

- **Adhesive Bonding of Reinforced Plastics—H. A. Perry. $8.75.** Survey of the design and assembly of structures and products, particularly glass-fiber-reinforced plastic products, by means of adhesives. Gives data on equipment and methods used to produce adhesive bonded joints. ☐

- **Adhesive Bonding of Metals—G. Epstein. $2.95.** Considers adhesives used with metals, indicating when an adhesive-bonded joint is advantageous; the type adhesive to use; how to use it, and how to design the joint for optimum performance. ☐

- **Epoxy Resins—Their Applications and Technology—H. Lee and K. Neville. $8.00.** Guide to the field of epoxy resins, covering the chemistry of their preparation and applications, including a section on adhesives. ☐

- **Polyamide Resins—Donald E. Floyd. $4.50.** Discusses in detail various important applications of the polymers belonging to the polyamide resin family and includes a comprehensive section on adhesives. ☐

- **Principles of High Polymer Theory and Practice —A. X. Schmidt and C. A. Marlies. $14.50.** Study of the principles of high-polymer theory and practice, with a section on adhesives, their applications, and mechanisms and factors involved. ☐

- **Recent Advances in Gelatine and Glue Research —G. Stainsby (Editor). $12.00.** Study of Collagen, and its protein gelatine, comprising papers and Proceedings of an International Conference of the British Gelatine and Glue Research Association. ☐

- **Vinyl Resins—Mayo Smith. $5.75.** Surveys applications of vinyl resins with information on their types, properties, chemistry, manufacture and fabrication. Includes information on several types of adhesives in this category. ☐

- **Epoxy Resins—Irving Skeist. $5.50.** A chapter on adhesives is included in this complete study of the entire field of epoxy resins. The author gives formulations, trade names, methods of manufacture and applications. ☐

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Trade Literature (cont'd.)

AIR POWERED EQUIPMENT. Equipment shown in this 32-page catalog includes mastic adhesives, caulking compounds and sealers, pumping systems to dispense paint, vinyl material for plastic molding, inks, underbody coatings, sound deadeners and similar fluid or semifluid materials. Specifications are given on "Power Master" pumps and other accessories. Also listed are hose, air controls, couplers, nipples and adapters needed for systems. The catalog also contains many photographs showing equipment in use. *Lincoln Engineering Company.* **L-437**

ADHESIVES FOR WOODWORKING. This booklet is packed with reference material which should be of interest to all members of the wood-working industry. Contents of the handy, file-size pamphlet discusses virtually everything from the basic wood to the finished products of the industry. Subjects, many of which are illustrated, include: adhesives; wood definition and types; laminating and assembly; and adhesive testing. Types of glue for all phases of the wood-working industry are described in their relation to various operations in the field. *H. B. Fuller Co.* **L-438**

AQUEOUS FOIL LAMINATING ADHESIVES. This special report on aqueous foil laminating adhesives incorporates a complete discussion on the physics of foil bonding, including mechanical attachment and polar adhesion. It also discusses required adhesive properties for foil applications and analysis of currently used foil adhesives, including neoprene-casein, butadiene-styrene, and nitrile latices, vinyl resins, and acrylic polymers. Foil adhesive problems and recommended solutions are also dealt with in the report. It also deals with techniques of retarding paper curl, and end-use of the foil laminate as a factor in adhesive selection. Technical data for all foil adhesives is reviewed with a listing of solids, viscosity, pH, weight per gallon, plus a table showing the effects of dilution upon viscosity. *Borden Chemical Co.* **L-439**

FOR MORE INFORMATION on the literature items described here, use the Readers' Service Coupon on page 44.

VIBRATORY HANDLING EQUIPMENT. A new condensed catalog, No. 616, contains information on vibratory materials handling equipment, vibrating parts handling equipment, mechanical shaft seals, paper joggers, portable power tools and power rectification equipment. The catalog contains over 200 illustrations and presents descriptions, data and specifications of the entire product line. *Syntron Co.* **L-440**

CLOTH TAPES. This comprehensive 12-page brochure describes the specific qualities, features, and uses of the manufacturer's complete line of pressure-sensitive and heat sealing cloth tapes, and illustrates the applications with on-the-job photographs. Also included are tape dispensing equipment available from the company, and government specifications for cloth tapes. *Permacel.* **L-441**

ULTRAVIOLET SPECTROPHOTOMETER. This 16-page illustrated brochure describes major features, outlines specifications, and explains the optical system and operating principles of the DB Ultraviolet Spectrophotometer. Numerous curves illustrating the double-beam instrument's capabilities are also included in Bulletin 779-B. *Beckman Instruments, Incorporated.* **L-442**

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Government Gold Mine

American businessmen soon will receive an open invitation to help themselves to a gold mine of information awaiting them at the headquarters and in the 33 field offices of the U.S. Department of Commerce. The invitation will be presented graphically through a new series of five Advertising Council advertisements appearing in space contributed by business publications.

Grey Advertising, Inc. of New York City developed the special campaign, on a volunteer basis, in consultation with the Department of Commerce and the Business Paper Advisory Committee of the Advertising Council. "Now's the Time to Get in a Growing America" is the theme of the campaign, now offered as an extension of the Council's "Confidence in a Growing America" project, started last March.

The advertisements invite businessmen to take advantage of a "9 billion dollar fund of research and patent information" available to them through Commerce. In the Commerce gold mine, the advertisements point out, run veins of lucrative, helpful free information on (1) domestic marketing of products and services, (2) foreign outlets for American companies, (3) community development, and (4) government patents and technical research.

In a letter to business paper publishers explaining the purposes of the campaign, the Secretary of Commerce Luther H. Hodges said: "We have reason to believe that many businessmen are not aware of the facilities we can offer them to help them increase their domestic or foreign markets, improve their products or processes, or participate in redevelopment of their areas."

Advice Yet

Chemical Processing reports that an Air-Force-sponsored study by University of Pennsylvania researchers has come up with the conclusion that a digital computer can probably be taught to give advice.

The researchers also believe that a computer can dream. Letting a computer dream is analogous to letting it predict willynilly.

In continuing experiments, the researchers hope to devise a model of a computer program that will simplify things by allowing input of data in natural language.

Efficiency

An article which appeared recently in the Kansas State Engineer seems worth quoting here. Under the title "How to be Efficient with Fewer Violins," the article purports to be the reaction of a methods engineer to his first symphony concert: For considerable periods the four oboe players had nothing to do.

The number should be reduced and the work spread over the whole of the concert, thus eliminating peaks of activity.

"All the twelve violins were playing identical notes; this seems unnecessary duplication. The staff of this section should be drastically cut. If a larger volume of sound is required, it could be obtained by electronic apparatus.

"Much effort was absorbed in the playing of demisemiquavers; this seems to be an unnecessary refinement. It is recommended that all notes should be rounded up to the nearest semiquaver. If this were done, it would be possible to use trainees and lower-grade operatives more extensively.

"There seems to be too much repetition of some musical passages. Scores should be drastically pruned. No useful purpose is served by repeating on the horns a passage which has already been handled by the strings.

"It is estimated that if all redundant passages were eliminated, the whole concert time of two hours could be reduced to twenty minutes and there would be no need for an intermission."

Those Mice Again

Two little white mice were all decked out in space suits, taped up with wires and strapped into a nose cone when one turned to the other, "What do you suppose is going to happen now, Joe?" "Darned if I know but it sure beats cancer research!" (*By Gum*, Reichhold Chemicals, Inc.)

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The latest word from Detroit is that planning a new model automobile is like love-making among the elephants. There's a great deal of trumpeting, everything of importance happens at a high level, and nothing comes of it for three years.

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Write for Technical Service Bulletins No. 72 and 75.

Neville Chemical Company, Pittsburgh 25, Pa.

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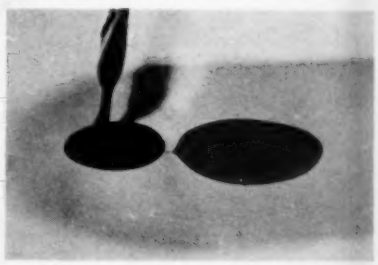
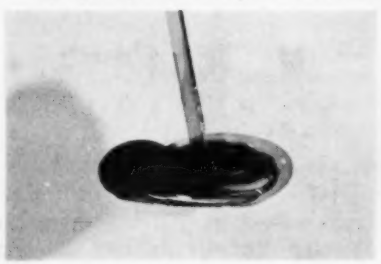


Equal parts by volume . . . one is red, the other amber . . . mix until streaks disappear . . . spread!



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